Vol. 6, No. 10 October 1996

GSA TODAY

A Publication of the Geological Society of America

INSIDE

Out of the Icehouse into the Greenhouse: A Late Paleozoic Analog for Modern Global Vegetational Change

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ABSTRACT

A change to global greenhouse conditions following deglaciation occurred during the late Paleozoic. The deep-past data set preserved in the stratigraphic record can serve as a model system to understand vegetational responses during this kind of climatic change, especially in the tropics. No other time in Earth history so mimics the late Cenozoic or provides the long-term data set from which generalizations can be deduced. Two long-term glacial cycles have been identified in Permian-Carboniferous time. The waxing and waning of glaciers during the height of either ice age resulted mainly in spatial displacement of vegetation, and also in minor variations in tropical climate. Brief intervals of rapid deglaciation at the end of the Middle Pennsylvanian (Westphalian) and mid–Early Permian (Sakmarian) were accompanied by major changes in plant assemblages, including extinctions, changes in the spatial distribution of plants in the tropics and temperate zones, and nearly synchronous changes in the structure of vegetation throughout the globe. Although the plants of the late Paleozoic and the geography of that time differed entirely from those of today, the rates, geographic distribution, and nature of vegetational changes can serve as portents of similar patterns in the transition to a modern greenhouse world.

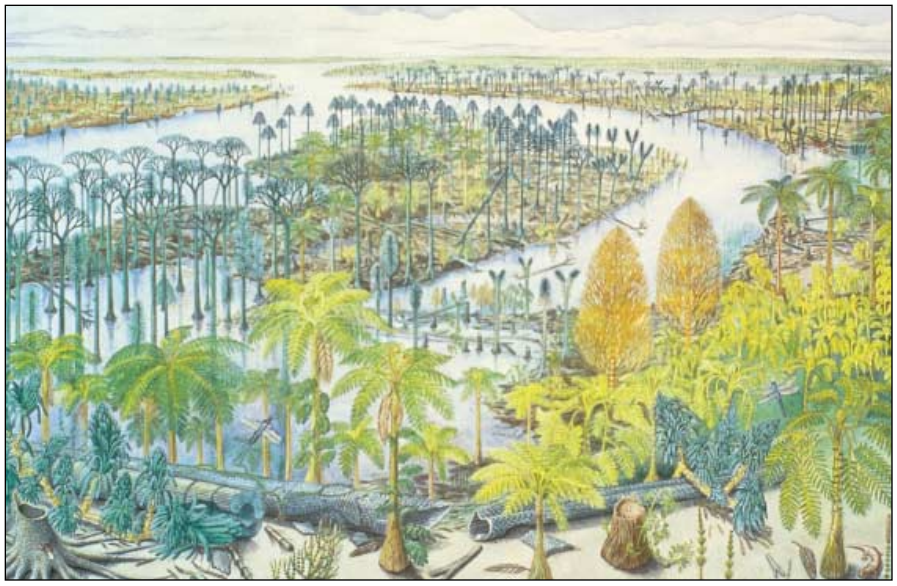

Figure 1. Reconstruction of middle late Carboniferous tropical coal swamp showing different plant communities made up of tree lycopods (L, tree club mosses), tree sphenopsids (two brushlike trees above letter S in center and tree scouring rushes), tree ferns (F), pteridosperms (P, seed plants with fernlike leaves; extinct group), and cordaites (C, seed plants with strap-shaped leaves; extinct group). From a painting by Alice Prickett, published in black and white in Phillips and Cross (1991, pl. 4).

Greenhouse *continued on p. 2*

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GSA TODAY

Vol. 6, No. 10 *October 1996*

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Greenhouse *continued from p. 1*

INTRODUCTION

Current debate over global warming has not resolved whether empirical observations reflect short-term excursions within longer term cyclical oscillations of climate or if they reflect a unidirectional long-term trend (Graham, 1995; Thompson, 1995; Webb, 1995). Regardless, a global greenhouse stands in marked contrast to the past 20 m.y. of glaciation and icehouse climate (Fischer, 1982). Consequently, the most recent icehouse period may be a poor model from which to deduce the likely dynamics of vegetational change under continuously directional warming. Other periods of pronounced greenhouse climate, such as the Late Cretaceous and late Eocene, do not reflect the icehouse-greenhouse climate transition. Rather, these intervals of time represent high points or thermal maxima within long-persistent greenhouse intervals (Ziegler et al., 1987), rendering them unsuitable as analogs for the present or the near future (Sellwood et al., 1994). The only time in Earth history when the mosaic of a complex terrestrial vegetation (Fig. 1) was subjected to a transition from icehouse to greenhouse conditions, similar to the one we may now be experiencing, was during the late Paleozoic (Frakes et al., 1992; Crowley, 1994). Comparison of the present and this deep-past record can lead us to a more realistic framework from which to attempt a prediction concerning the dynamics of vegetational change during a period of icehouse to greenhouse climatic change.

In any period of rapid environmental modification it will be crucial to understand the fundamental principles that underlie vegetational change and recovery from disturbance. Such principles can be deduced from an understanding of late Paleozoic vegetational responses because of several parameters. The biota of the late Paleozoic was entirely distinct from that of today, providing an independent data set from which we can deduce general plant responses to changing extrinsic conditions. This is due, in large part, to the presence of similar environmental stresses that resulted in plant responses producing plant structure and architecture (sensu Halle, et al., 1978), life history spectra, and reproductive strategies similar to those of vegetation of the present. The floristic biogeography and zonation of the late Paleozoic parallel those of today (Ziegler, 1990). Overall, then, the systematic differences can be viewed as a means of strengthening the possibilities of recognizing fundamen-

Greenhouse *continued on p. 3*

In Memoriam

J. Wyatt Durham
Kensington, California
July 10, 1996

William H. Easton
Westlake Village, California
July 7, 1996

S. Warren Hobbs
Fort Collins, Colorado
May 1996

Ronald E. McAdams
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Houston, Texas

Curt Teichert
Arlington, Virginia
May 10, 1996

Harry Tourtelot
Rolla, Missouri
July 17, 1996

Greenhouse *continued from p. 2*

tal processes and permitting generalizations to be made about how vegetation responds to changing climate. The late Paleozoic plant record consists of assemblages that are preserved with high resolution and fidelity (Behrensmeyer and Hook, 1992; Burnham, 1993) in sedimentary environments representing fluvial, lacustrine, coastal plain, and deltaic settings. Plants colonized a wide variety of substrates, and communities are known from peat and clastic alluvial sediments. These assemblages provide snapshots in time of vegetational patterns during both glacial and interglacial cycles over the entire icehouse-greenhouse interval. Finally, late Paleozoic tropical plants and plant ecosystems are as well known as and possibly better known than their Holocene counterparts, in terms of their long-term response to abiotic stresses (sea level and climate fluctuations). From the late Paleozoic record, we conclude that many effects of an icehouse-greenhouse transition will probably be expressed dramatically in the tropics.

The late Paleozoic encompasses the decline of Earth's primeval forests and their replacement by seed-plant-dominated vegetation more typical of the Mesozoic. Increases in greenhouse gasses during the late Paleozoic occurred over millions of years (Berner, 1990, 1991; Graham et al., 1995). In contrast, similar accumulations may occur within markedly shorter intervals of time today (Francey et al., 1995). However, the time required for changes in plant life might not be significantly different. While late Paleozoic stages, as defined by plant fossils, lasted from 1 to 2 m.y., the change from one flora to another (widespread extinction, radiation, and propagation) marks the boundary between stages. We cannot yet put numerical values on the length of time over which these turnovers occurred. However, the resolution of time within stratigraphic sections is increasing. In specific cases it is possible to constrain time either in the range of orbital cycles or even months for tidal sediments. In the near future we can expect to find stratigraphic sections that will allow us to put numerical values both on the duration of change-overs and on intervals of stasis. We expect change-overs to be in the range of 1–10 ka.

LATE PALEOZOIC GLACIATION

Polar glaciation began in the latest early Carboniferous (Visean-Namurian) and fluctuated in magnitude throughout the Permian-Carboniferous (Fig. 2). During these 75+ m.y., two ice ages peaked, one during the late Middle Pennsylvanian (late Westphalian) and the other in the Early Permian (Sakmarian). Orbital-driven glacial and interglacial oscillations were superimposed on these long-term trends (Frakes et al., 1992). The maximum extent of ice caps expanded gradually over the continents, taking an estimated 20 m.y. to reach their greatest coverage. Increasing evidence indicates that each ice age terminated abruptly over 1–10 ka.

The extent of polar glaciations (coverage and ice mass) during Milankovitch cycles has a direct effect on the distribution of rainfall in the tropics by affecting the pattern of atmospheric circulation and the latitudinal range and width of the intertropical convergence zone (Ziegler et al., 1987; Pfefferkorn, 1995). During glacial maxima, the intertropical convergence zone contracts toward the equator and migrates over a narrower latitude, resulting in ever-wet conditions within its area of influence. In contrast, during interglacial intervals, the intertropical convergence zone expands latitudinally and migrates during the yearly cycle over a wider latitudinal belt, resulting in a change of climatic patterns and greater oscillations in seasonal moisture availability in the tropics. Specifically, there are much larger areas that experience strong wet-dry seasonality.

During the Middle Pennsylvanian (Westphalian) ice age, the waxing and waning of polar ice caps and glaciers were represented in the Euramerican tropics by cyclical sedimentary patterns. During Middle Pennsylvanian (Westphalian) glacial maxima, extensive peat-accumulating swamps developed under an ever-wet climate. Marine sediments reflecting a wide variance in climate were deposited during interglacial periods (glacial minima). Such sea-level changes are evidenced by paralic sequences bounded by transgressive erosional surfaces (Gastaldo et al., 1993) and may be covariant with changes from ever-wet to seasonally dry climates (Cecil, 1990). During the Early Permian glaciations, in contrast to the Westphalian, peat accumulation was far more limited and localized in areas of wettest tropical climates. Interglacials of that time period also were more intensely seasonal than comparable intervals in the Westphalian, on the basis of vegetational and paleosol patterns (Broutin et al., 1990).

During the Late Pennsylvanian (Stephanian), which falls between the two ice ages, Earth may have been warmer (Dorofyeva et al., 1982). Evidence from coal-resource distributional patterns (Phillips and Peppers, 1984) and from biofacies analysis (DiMichele and Aronson, 1992) indicates a generally drier or more seasonal Late Pennsylvanian (Stephanian) interval with pulselike oscillations between overall wetter and drier periods. These oscillations continued into the Permian, with an increasing prominence of drier climates in tropical lowland and intermontane areas. Drying continued

Greenhouse *continued on p. 4*

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Greenhouse *continued from p. 3*

throughout the Permian, and ice caps and peat-accumulating systems were lost (Retallack, 1995). By latest Permian time, compressional tectonics, the oxidation of peat resources, and volcanic processes may have introduced vast quantities of CO_2 into the atmosphere, driving global temperatures toward their maximum (Erwin, 1996).

LATE PALEOZOIC VEGETATION

The beginning of the Carboniferous is marked by a radiation of vascular plants that established five major groups. During the late Paleozoic, ecological dominance was strongly partitioned by the different higher taxonomic groups (see Fig. 1): tree club mosses (rhizomorphic lycopsids) in swampy wetlands; tree scouring rushes (sphenopsids) in aggradational environments; ferns, including tree ferns, as weeds in a variety of disturbed settings; and seed plants (seed ferns or pteridosperms and cordaites) in better drained habitats. However, temporal and spatial exceptions are known to have existed—as, for example, peat-forming cordaites and pteridosperms. The dominance of each group of plants in a particular environment distinguishes the Carboniferous from later time periods. By the end of the Paleozoic, these patterns and groups had yielded, through a series of steps, to seed plants, which began to dominate in most habitats throughout the world (Niklas et al., 1983).

Permian-Carboniferous terrestrial vegetation can be divided into three broad biogeographic realms (Fig. 3): (1) the pantropical Euramerican (or Amerosinian) floral realm (Wagner, 1993), the best known and most intensively studied, (2) the north-temperate Angaran floral realm (Meyen, 1982), and (3) the south-temperate Gondwanan floral realm (Archangelsky, 1990). These three biogeographic realms were occupied by different plants, but the vegetational turnover occurred in all three at about the same time (Wagner, 1993). However, there might be differences in the timing of turnover of as much as one stage between different climatic belts, owing to the buffering of environmental change by local or regional physiographic differences and the resulting lag time in vegetational turnover. These major vegetational turnovers appear to be in part the result of geologically rapid (1–10 ka) migrations of groups of plants from one climatic belt to another. In contrast, slow migration of genera or species over millions of years has been documented by Laveine (1993). These two processes are different in nature and should not be confused. Knowledge of the slow migration can improve our understanding of biogeographic barriers during times of evolutionary stasis.

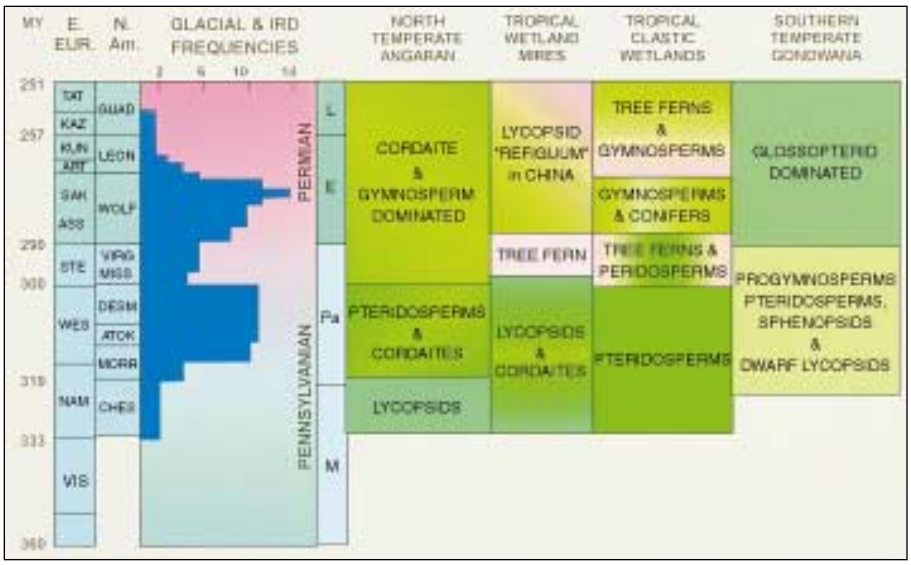

Figure 2. Relation between global glaciation and vegetative change during the late Paleozoic in different tropical environments and the north and south temperate belts. Glacial ice extent, from Frakes et al. (1992), is based upon tillites (glacial) and ice-rafted deposits (IRD). Vegetation distributional patterns are derived from sources cited in the text. M = Mississippian; Pa = Pennsylvanian; E = Early; L = Late; VIS = Visean; NAM = Namurian; WES = Westphalian; STE = Stephanian; ASS = Asselian; SAK = Sakmarian; ART = Artinskian; KUN = Kungurian; KAZ = Kazanian; TAT = Tatarian; CHES = Chesterian; MORR = Morrowan; ATOK = Atokan; DESM = Desmoinesian; MISS = Missourian; VIRG = Virgilian; WOLF = Wolfcampian; LEON = Leonardian; GUAD = Guadalupian.

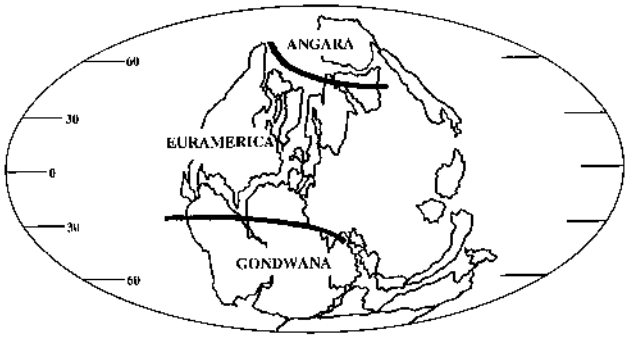

Figure 3. Distribution of floral realms in latest Pennsylvanian time (290 Ma). Northern temperate (Angara), tropical (Euramerica), and southern temperate (Gondwana) realms can be distinguished. Continental position redrawn from Denham and Scotese's 1988 computer program, Terra Mobilis.

Major vegetational changes have been noted at the base of the Late Carboniferous, within the Early Pennsylvanian (Namurian), near the Middle-Upper Pennsylvanian (Westphalian-Stephanian) boundary, during the transition from the Carboniferous to the Permian, and near the Sakmarian-Artinskian boundary. Each changeover corresponds to significant increases or decreases in polar ice volumes and global temperature (Fig. 2). In all these cases and in all parts of the world, the patterns of vegetational organization yield to increased dominance by opportunistic weedy taxa or, ultimately, to the extinction-resistant life histories of seed plants.

TROPICAL PATTERNS

Each of the floral realms can be subdivided into "biomes" characteristic of particular climatic and ecological conditions, and each is further subdivisible into landscape units. The Euramerican realm includes a "wet" biome, characterized by mire (peat-forming) and clastic (floodplain) wetland vegetation. These are the plants typically reconstructed in most Carboniferous "coal swamp" dioramas. Less well known, but present throughout most of the Late Carboniferous, was a tropical "dry" biome with a flora rich in gymnosperms and which included conifers (Lyons and Darrah, 1989). This flora entered the tropical lowlands only during short periods of regional dryness (probably the result of increased seasonality; Elias, 1936; DiMichele and Aronson, 1992).

Mires within the "wet" biome were dominated by lycopsids and cordaites throughout the Middle Pennsylvanian (Westphalian); tree ferns appeared in mires of the latest Middle Pennsylvanian (mid–Westphalian D). Following major extinctions at the Middle-Late Pennsylvanian (Westphalian-Stephanian) boundary that reached nearly 70% of the known species (DiMichele and Phillips, 1996),

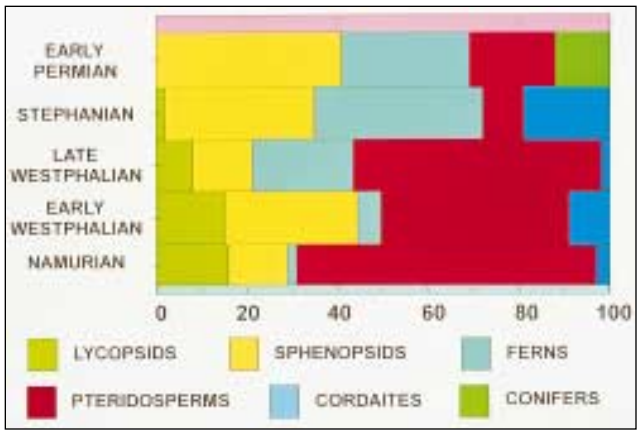

Figure 4. Changes in dominance patterns of major plant groups in the clastic swamp environment of the tropics throughout the Pennsylvanian (late Carboniferous) and earliest Permian. Data from North America and Europe (Pfefferkorn and Thomson, 1982).

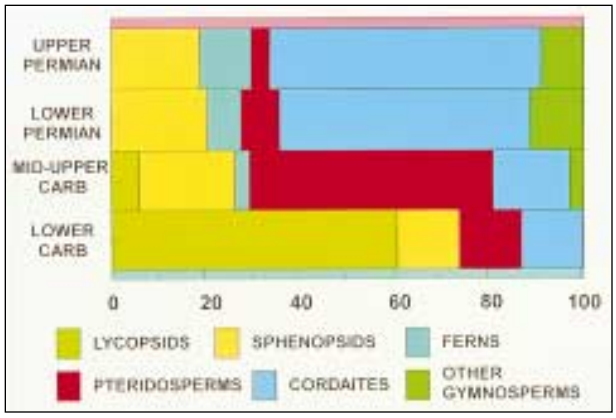

Figure 5. Changes in dominance patterns of major plant groups in the clastic swamp environment of the northern temperate realm throughout the Pennsylvanian (late Carboniferous) and Permian. Data from Kazakhstan (Meyen, 1982).

tree ferns dominated Late Pennsylvanian mires.

Clastic wetland habitats were largely pteridosperm dominated throughout the Middle Pennsylvanian (Gastaldo, 1987). Beginning in the latest Middle Pennsylvanian, tree ferns rapidly established themselves as codominants and continued as dominant to codominant taxa throughout the Late Pennsylvanian (Pfefferkorn and Thomson, 1982). The predominance of tree ferns during the Late Pennsylvanian followed extinctions in the clastic wetlands that, although less severe, paralleled those of the mires. The extinctions within the pteridosperm groups were accompanied by speciation that vastly increased the number of tree fern taxa of the later Paleozoic (Fig. 4).

The extinction events at the Middle Pennsylvanian–Late Pennsylvanian (Westphalian-Stephanian) boundary induced a thresholdlike internal reorganization of the wetlands (DiMichele and Phillips, 1995). The tree ferns that became dominant descended from opportunistic weedy forms in the older Westphalian landscapes. These plants were well suited to compete for space and resources in disrupted, postextinction landscapes, owing to their reproductive strategy of producing massive quantities of highly dispersible spores, a "cheaply" constructed body (one consisting largely of simple parenchyma cells), and an ability to tolerate low nutrient conditions. This signaled the beginning of the breakdown of the landscape between groups of plants. The high taxonomic level at which the data are summarized in Figures 2, 4, and 5 masks certain patterns at lower levels of ecological organization, particularly the persistence of dominance-diversity patterns within habitats and the replacement of species on ecomorphic themes through time (DiMichele et al., 1996). The major patterns revealed by these data are persistence of communities and landscapes over millions of years, disrupted only by major extinction events that lead to relatively rapid reorganization and establishment of new persistent patterns.

In spite of renewed polar glaciation, pulselike climatic drying continued throughout the tropics into the Early Permian. Continued drying, in part the result of Pangean assembly, progressively eliminated tracts of continuous wetland habitat crucial to the survival of the wet biome. The exception occurs in south China, where a Westphalian-type flora persisted in mires until the Late Permian (Guo, 1990). Seed plants, which were resistant to increasingly dry conditions by virtue of both reproductive and vegetative adaptations, became the dominant elements in most tropical habitats, even in geographically isolated patches of wetlands. The Chinese "refugium" never served as a source for repopulation of the wetlands elsewhere in the world during the Permian. The transition from the wet to the dry biome was not accompanied by extensive mixing of the component species. Rather, each retained its distinctive taxonomic and ecomorphic characteristics. At this temporal scale, replacement rather than a competitive displacement is strongly indicated. Additionally, it appears that higher levels of ecological organization may have spatial-temporal unity and take part in dynamics not predictable from the study of lower level population or community dynamics. The biomic transition appears to have been independent of internal vegetational dynamics that occurred within each biome.

The dry biome became increasingly dominated by conifers in parts of Euramerica throughout the Asselian (Broutin et al., 1990). It was not until the Sakmarian-Artinkskian deglaciation that tree ferns re-emerged as dominant elements within a vegetation that was characterized by a diversity of seed plants (Read and Mamay, 1964). Their re-emergence indicates a change to increased moisture availability within the tropics.

NORTH-TEMPERATE PATTERNS

The Angara floral realm was dominated by a lycopsid-rich flora prior to the onset of polar glaciations (Fig. 5). At or near the middle to late Namurian boundary, the lycopsid flora was replaced by a low-diversity but widespread flora dominated by seed ferns and cordaiteans (Ruflorians) that were persistent throughout the Middle Pennsylvanian wetlands. Near the Middle Pennsylvanian–Late Pennsylvanian boundary a further floristic change ensued, resulting in the rise of high-diversity cordaite-dominated assemblages (Ruflorian 2 assemblage) (Meyen, 1982); Wagner (1993) suggested that this floral change may be coeval with time-equivalent tropical vegetational changes. The pteridospermalean (seed fern) component of the Angaran Middle Pennsylvanian flora is the major casualty following vegetational reorganization. The subsequently dominant, cordaite-rich floras (Ruflorian 3) have been suggested to be tolerant of freezing conditions. As in the tropical zone, the floras of Angara become progressively more enriched in and dominated by other seed plants (gymnosperms) as major climatic changes caused extinctions in, and reorganizations of, the regional ecological structure (Fig. 5).

SOUTH-TEMPERATE PATTERNS

As in the tropical and north temperate zones, the Gondwana zone had several distinct vegetational regions in the late Paleozoic (Cuneo, 1996b). The northernmost parts of the Gondwana continent

Greenhouse *continued on p. 6*

Greenhouse *continued from p. 5*

(northern South America and North Africa) were in the tropics, and fossil assemblages from these areas are distinctly Euramerican. All other parts of the continent were in the south temperate Gondwana biogeographic zone. Major floral changes occurred on the Gondwana continent in the Southern Hemisphere at or near the mid-Carboniferous and Carboniferous-Permian boundaries. Prior to the mid-Carboniferous and the inception of glaciation, biomes were characterized by progymnosperms and pteridosperms. There is still debate as to the exact timing of floral change, because the onset of glaciation may have affected the plant biogeography in continental interiors earlier (Archangelsky, 1990).

Floristic turnover at the mid-Carboniferous boundary is characterized by a flora that was made up of taxa like *Nothorhacopteris*, which appear to be similar in aspect to forms dominating early Carboniferous floras in the tropics. Several of the dominant taxa were considered to be progymnosperms. However, recent work has shown that some of them were pteridosperms (Vega and Archangelsky, 1996; Galtier, 1996). Scouring rushes (sphenopsids) and club mosses (lycopsids) also were present, but they were small in the cooler areas; they grew to tree size only in the warmer areas (Peru, Niger). Ferns were rare or absent. The highest diversity floras occupied the lower latitudes, whereas the low-diversity floras are known from more poleward regions.

At or near the Carboniferous-Permian boundary, this late Carboniferous flora was replaced by one dominated by seed-bearing glossopterids, large trees with deciduous leaves (Cuneo, 1996a). Early glossopterids appeared suddenly, accompanied by the extinction of many of the Carboniferous elements. The simple venation of these early forms cannot be distinguished from the genus *Lesleya* that occurred in seasonally dry areas of the tropics as early as earliest Pennsylvanian (Namurian) time in Illinois (Leary, 1980). If actually related to glossopterids, *Lesleya* would have been at least partly preadapted to a seasonally cold climate of the Southern Hemisphere (Leary, 1980; Archangelsky, 1990) by virtue of its origin in seasonally dry parts of the tropics.

The *Glossopteris*-dominated flora persisted throughout the Permian and diversified in complexity of leaf venation and reproductive structures. In addition, tropical plants appeared in the temperate areas in response to higher rainfall and due to the drying of most of the tropical areas. The temperate areas of Gondwana were clearly not very cold (Cuneo, 1987), certainly much warmer than hypothesized by climate models (Yemane, 1993). This is reflected in the successful colonization by conifers, sphenopsids, ferns, pteridosperms, ginkgophytes, and cordaites. One aspect that has been neglected in most previous discussions is the fact that there must have been glacial and interglacial intervals and that the interglacial periods could have been very warm, providing for part of the vegetational record.

DISCUSSION

The late Paleozoic offers the best pre-Pleistocene opportunity to observe the response of terrestrial vegetation to short-term and long-term fluctuations in glacial conditions, the ultimate end of an ice age, and change to a global greenhouse. In fact, the patterns of change in the tropics, in particular, appear to be better documented for the Permian-Carboniferous tropics than for those of today. Several conclusions and generalities can already be drawn from study of these long-extinct ecosystems.

Despite difficulties in correlation, a case can be made for approximate synchroneity of changes in plant communities throughout the world in response to severe global physical stresses. These consequences might be offset in time by as much as a stage because some climatic belts or environments are able to buffer consequences of changes until threshold levels are overcome. The "recovery" phases following periods of major glacial onset or retreat are complex and dependent on local factors, both biotic (for example, ability of species to extend their ranges into an area) and abiotic.

Ecosystems appear to be able to "absorb" regional to global species extinctions below some threshold level. Our data do not yet permit us to pinpoint this with great accuracy, but it appears to be less than 50% and probably more than 10% of common species of trees and shrubs. Such background turnover and replacement are visible at the species level in data derived from peat-forming mires and clastic wetlands. When this threshold extinction level is surpassed, reorganization takes place and results in a different dominance-diversity structure. Floras and vegetation in both the tropical and north-temperate regions persist for millions of years despite background extinction, only to change approximately simultaneously during a period of glacial onset or deglaciation and global warming.

When ecosystems are physically disrupted by short-term but severe and widespread perturbations, opportunists will have a distinct advantage in securing and maintaining dominance. The lowland-wetland, tropical Late Pennsylvanian (Stephanian) is, in some ways, analogous to an extended "fern spike" recognized as the initial recovery phase following the Cretaceous-Tertiary extinction event (Nichols et al., 1986).

The concept of refugium is elusive. An area of survival of archaic vegetation (relative to the rest of a floristic realm) does not constitute a refugium if the plants cannot migrate back to previously occupied areas when conditions return to those approximating the pre-extinction environment. Both abiotic factors, such as the lack of clear routes of dispersal, and biotic factors, such as incumbent advantage, can prevent an expansion of vegetation from a potentially refugial area.

Ultimately, species with life histories and structural adaptations that precondition them to survive under physically inhospitable conditions will survive to attain dominance. During the late Paleozoic these were almost exclusively groups of seed plants. The pattern has continued, with subsequent global and regional ecological perturbation resulting in dominance of the landscape by an ever narrowing phylogenetic spectrum of plants after the late Paleozoic. Within the seed plants, dominance has been narrowed largely to angiosperms. Within angiosperms, composites and grasses have become ever more dominant over wider areas of Earth's surface as a consequence of climatic changes.

Patterns in the late Paleozoic provide us with one certainty: global warming presents plants with conditions that are markedly different from those found during periods of icehouse climate. The waxing and waning of glaciers are, in and of themselves, a climate-mode to which vegetations become attuned. Global warming breaks the mold and encourages the establishment, quite rapidly (in geological terms at a stage boundary; probably on the order of 1–10 ka), of new kinds of vegetation, the origins of which are as much due to evolutionary innovation as to reorganization of species associations. Extinctions break the hold incumbent taxa have over the resources and favor or permit the establishment of new species, although apparently those descended from opportunistic and/or extinction-resistant ancestors. Past patterns, when coupled with recently developed ecological concepts such as the recognition of thresholdlike responses to perturbation (Kareiva and Wennergren, 1995), provide a basis to speculate on responses to change. Although the interactions between vegetation and climate are complex, they do conform to some general and recurrent patterns that exist on different scales in space and time. Recognizing patterns and principles of change at the icehouse-greenhouse transitions of the late Paleozoic will enable us to use this understanding to make predictions about changes to come.

ACKNOWLEDGMENTS

William L. Crepet, Louis Derry, Robert W. Kay, and two anonymous reviewers offered helpful discussions and

review of the manuscript. We thank T. L. Phillips for granting permission to use the reconstruction of a Pennsylvanian peat swamp. This research has been supported by various funding agencies, including the National Science Foundation to Gastaldo, the American Chemical Society, the Deutsches Forschung Gemeinschaft, the Research Foundation of the University of Pennsylvania, and the Smithsonian Institution. Evolution of Terrestrial Ecosystem Program contribution #30.

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Manuscript received July 1, 1996; revision received August 7, 1996; accepted August 9, 1996. ■

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'Town Meetings'
Directorate for Geosciences
National Science Foundation

The Directorate for Geosciences (GEO) of the National Science Foundation (NSF) is planning to convene a series of 'town meetings' with the geosciences community to discuss the goals and objectives that NSF seeks to accomplish through the support of the geosciences. These are intended to provide a forum for the geosciences community to discuss with NSF/GEO staff issues central to the future of our sciences. Given the outlook for constrained budgets and the impacts of budget cuts in other agencies, the discussions will focus on the scientific strategies and management approaches that are under consideration by GEO to achieve those goals while continuing to protect the health of the geosciences.

'Town meetings' are presently being arranged in conjunction with the following scientific meetings:

GSA	Denver, CO Wednesday, October 30 Colorado Convention Center	October 27-31, 1996 5:45 to 7:45 p.m. Room A202-204
AGU	San Francisco, CA Sunday, December 15 Moscone Center	December 15-19, 1996 Time: TBA Room: TBA
AMS	Long Beach, CA Monday, February 3 Long Beach Convention Center	February 2-7, 1997 12:00 noon to 1:30 p.m. Ballroom B
ASLO	Santa Fe, NM	February 10-14, 1997
TOS	Seattle, WA	April 1-4, 1997
AGU	Baltimore, MD	May 19-23, 1997

The NSF/GEO booth is also planned for these scientific meetings.

These 'town meetings' are expected be informal, open exchanges of ideas, concerns and suggestions and are scheduled for two hours each. Senior staff from NSF's Office of the Assistant Director for Geosciences and from GEO's Divisions of Atmospheric, Earth and Ocean Sciences will participate.

The specific dates, times and locations of the 'town meetings' will be advertised as far in advance as possible and at the scientific meetings at which they are to be held. Your comments on the proposed 'town meetings,' their format, and the issues to be discussed are invited. Please send comments and suggestions to: geo@nsf.gov

WASHINGTON REPORT

Bruce F. Molnia

Washington Report provides the GSA membership with a window on the activities of the federal agencies, Congress and the legislative process, and international interactions that could impact the geoscience community. In future issues, Washington Report will present summaries of agency and interagency programs, track legislation, and present insights into Washington, D.C., geopolitics as they pertain to the geosciences.

Oceanographic Partnership Program

The need exists for a formal mechanism to coordinate existing partnerships and establish new partnerships for the sharing of resources, intellectual talent, and facilities in the ocean sciences and education, so that optimal use can be made of this most important natural resource for the well-being of all Americans.

—Sec. 281(4) of the National Oceanographic Partnership Act

The Defense Appropriation Acts of both Houses of Congress contain sections directing the Secretary of the Navy to establish a National Oceanographic Partnership Program, a National Oceanographic Research Leadership Council, and an Ocean Research Advisory Panel. Language contained in the legislation states that the purpose of the program is "to promote the national goals of assuring national security, advancing economic development, protecting quality of life, and strengthening science education through oceanographic research and development." The leading proponent of the Program is Congressman Curt Weldon (R-PA), who, with Patrick Kennedy (D-RI), introduced and sponsored the legislation in the House. Weldon, who has declared 1996 as the "Year of the Oceans," was assisted in formulating the legislation by the Consortium for Oceanographic Research and Education, headed by former Chief of Naval Operations, Admiral James Watkins.

The rationale for this legislation is clearly presented in Sec. 281, the "Findings" section of the Act which states "(1) The oceans and coastal areas of the United States are among the Nation's most valuable natural resources, making substantial contributions to economic growth, quality of life, and national security. (2) Oceans drive global and regional climate. Hence, they contain information affecting agriculture, fishing, and the prediction of severe weather. (3) Understanding of the oceans through basic and applied research is essential for using the oceans wisely and protecting their limited resources. Therefore, the United States should maintain its world leadership in oceanography as one key to its competitive future."

The program is designed to leverage all U.S. oceanographic efforts to the benefit of the nation. Membership of the 19-member Oceanographic Leadership Council would consist of the Secretary of the Navy (chairman), the Administrator of the National Oceanic and Atmospheric Administration (vice chairman), the Director of the National Science Foundation, the Administrator of the National Atmospheric and Space Administration, the Deputy Secretary of Energy, the Administrator of the Environmental Protection Agency, the Commandant of the Coast Guard, the Director of the U.S. Geological Survey, the Director of the Defense Advanced Research Projects Agency, the Director of the Minerals Management Service, the President of the National Academy of Sciences, the President of the National Academy of Engineering, the President of the Institute of Medicine, the Director of the Office of Science and Technology Policy, the Director of the Office of Management and Budget, a member from the ocean industries, a member from the state governments, a member from academia, and another member to be appointed by the chairman.

Understanding of the oceans through basic and applied research is essential for using the oceans wisely and protecting their limited resources. Therefore, the United States should maintain its world leadership in oceanography as one key to its competitive future."

The role of the council would be to coordinate national oceanography programs, partnerships, and facilities and to coordinate policy efforts of all federal activities involved in oceanographic surveys and research. The council would also provide a comprehensive plan to ensure development of oceanography science and technology modeling and simulation programs throughout government, universities, and industry that will be available to support military requirements in the future. The provision would also create a national ocean-data and remote-sensing center to centralize all unclassified, classified, and sensitive compartmented information databases; models and product synthesis capabilities to support national oceanographic requirements; and a national natural littoral laboratory. The Senate amendment would provide funding in the Navy's Oceanographic and Atmospheric Technology program for support of the National Oceanographic Partnership Act. The Senate amendment also contained a provision that would establish national coastal data centers on both the east and west coasts at existing institutions of higher learning with well-established institutes or graduate schools of oceanography. Differences between the House and Senate versions will be worked out in conference.

The provision would also direct the National Oceanographic Leadership Council to review the requirement for the establishment of centers for the national centralization of oceanographic research data, including coastal data centers, and to establish such centers as it deems necessary. The first annual report of the Council is to be submitted to Congress no later than March 1, 1997.

The Ocean Research Advisory Panel, consisting of 10 to 18 members, would be appointed by the council "from among persons who are eminent in the fields of marine science or marine policy, or related fields, and who are representative, at a minimum, of the interests of government, academia, and industry." Advisory Panel Members are to be appointed "no later than January 1, 1997."

Earlier this year at the House hearings on the oceans, Admiral Watkins pointed out that 47 committees in Congress have oversight responsibilities over some aspect of federal oceanographic programs. He also showed that nine agencies perform oceanographic research. If successful, the new program will ensure that the U.S. taxpayer and the U.S. scientific community get the maximum return possible for the ever-dwindling oceanographic research dollar. ■

Institute for Environmental Education

Interdisciplinary Scientific Opportunities at the Newly Consolidated U.S. Geological Survey and National Biological Service

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BACKGROUND

By Congressional mandate, the National Biological Service (NBS) has been merged into the U.S. Geological Survey (USGS), and is now the new Biological Resource Division of the USGS. This merger creates the potential to leverage bureaucratic change into scientific advance by forming an organization that unifies previously disparate environmental science activities. To help ensure that this potential is fulfilled, the Geological Society of America, Ecological Society of America, and Keystone Center sponsored two regional workshops to identify new interdisciplinary scientific opportunities relevant to the mission of the newly consolidated USGS and NBS, especially in the context of the Department of Interior's (DOI) trust responsibilities for land and resource management. Achievement of this mission may depend on the development of a framework for scientific investigation and information management that integrates knowledge on biological, physical, and socioeconomic processes and forces.

This report summarizes the results and findings of the first workshop, held in Washington, D.C., on June 4 and 5, 1996. Workshop participants included scientists and natural resource managers from a wide range of sectors including academia, nonprofit organizations, private companies, state and federal agencies that work with the USGS and NBS, and the USGS and NBS themselves.

OVERARCHING ISSUES

Five overarching issues emerged that are pertinent to the initiatives developed at the workshop.

1. The combined USGS-NBS should recognize adaptive resource management as a guiding principle. Adaptive resource management is an iterative procedure that incorporates goal setting, management, monitoring, and assessment in a process that leads simultaneously to improved understanding of ecosystem dynamics and improved resource management through time.

2. Baseline data on the state of ecosystems and watersheds are commonly lacking or inadequate; collecting and compiling integrated biological and physical baseline data are necessary prerequisites for successful resource management.

3. The USGS-NBS must develop comprehensive data acquisition, storage, retrieval, and archiving policies that allow full utilization of existing data, integration of physical and biological data sets, quality control of data, and appropriate allocation of resources for collecting new data.

4. Many new interdisciplinary initiatives can combine, build on, and leverage existing USGS and NBS programs.

5. The USGS-NBS should cultivate effective lines of communication and maintain strong ties with the NBS client community (federal, state, local, nonprofit, and private sector), in order to ensure the success of the merger.

PROPOSED INITIATIVES

I. Scientific Needs and Opportunities

Numerous high-priority interdisciplinary scientific initiatives relevant to the mission of the merged USGS and NBS were identified during the workshop; these are grouped into the following seven categories. Order of presentation is not meant to imply relative priority among the initiatives.

A. *Restoration*. Provide leadership for setting restoration goals, monitoring goal achievement, synthesizing results, and applying results to future action (i.e., adaptive management). Work with willing partners to choose a diverse set of pilot sites to demonstrate how to: select sites (in a landscape perspective); assess potential ecological states; set restoration goals (i.e., define desired ecological state); identify information needs; conduct monitoring; and evaluate results. Use results from demonstration projects to provide "lessons learned" to a broad audience of potential users.

B. *Sustainability*. For high-use terrestrial habitats, define thresholds beyond which systems are no longer resistant or resilient. Implementation steps include: identifying a diverse set of at-risk habitats; synthesizing current data and conducting needed research to define habitat-specific thresholds; recommending long-term monitoring and adaptive management strategies for various habitats.

C. *Non-Indigenous Species*. Determine invasion dynamics, management implications, and treatment options for problematic non-indigenous species. Implementation steps include: identifying problematic species and vulnerable habitats as defined by user needs; prioritizing and selecting species and diverse habitats for study; defining current state of knowledge for the selected species and habitats; undertaking targeted research in conjunction with users and DOI clients; developing treatment options and monitoring approaches in cooperation with appropriate partners.

D. *Species Distribution: Identification and Density of Organisms—Systematics*. Support acquisition of baseline data, surveys of the distribution and density of critical species and habitats, training of systematists, and involvement of the systematics community to enhance productivity and efficiency. USGS should serve as a clearing house for distribution and density information, and incorporate these data into georeferenced meta-databases.

E. *Natural and Altered Biogeochemical Cycling*. Determine impacts of major land uses (e.g., grazing, mining, logging, recreation) on local and regional biogeochemical cycles, especially water, carbon, nitrogen, and phosphorus. Evaluate impacts of various land uses on a range of habitats (e.g., hydrogeologic, vegetative, soil), and evaluate existing best management practices for each of these habitats.

F. *Implications of Physical and Ecological Boundaries on Ecosystem Management*. Rapid rates of ecological change may be concentrated at ecosystem, geomorphic, geologic, and/or hydrologic boundaries. Ecological and physical processes at these boundaries may have cascading (controlling) effects on each "side" of the boundary. Proper management of the contiguous systems of interest (e.g., stream and riparian zones) requires knowledge of boundary processes, provided by interdisciplinary teams of scientists, and the integration of data sets that have traditionally been collected and analyzed separately.

IEE *continued on p. 11*

IEE *continued from p. 10*

Sub-initiative on buffer strips: Define habitat-specific spatial scale of buffer strips and conditions where they can be effective for resource protection, versus those where they are inappropriate or ineffective. Prioritize information needs and undertake targeted research, including monitoring, to improve the state of knowledge and develop improved guidelines for the use of buffers.

G. *Evaluating Multiple Stressors: Ecological Risk Assessment and Ecosystem Modeling.* Land and resource managers lack information on the biological and physical modifications of the environment, or stressors, that affect their resource responsibilities; on the potential impacts of each of these stressors; and on the combined impacts of multiple stressors. Techniques for stressor analysis should be formalized to create ecological risk assessment methodologies that can weigh the comparative risks from diverse and multiple stressors, in light of land and resource management practices and policies. Modeling of ecosystem evolution can allow resource managers to anticipate how particular kinds of ecosystems will respond to interactions between natural factors and human activities, to identify systems at risk from particular stressors, and to set priorities for management practices. Model validation requires integration of data gathered via broad-scale monitoring, remote sensing, and process-based, site-specific research, undertaken as part of adaptive management strategies.

II. Tools and Technologies

Workshop participants identified three high-priority initiatives for data collection and management relevant to the agency mission.

A. *Monitoring.* Develop a conceptual design and pilot effort for a robust monitoring approach for biological and physical attributes of terrestrial and aquatic systems. Identify current monitoring sites and systems—what data already exist? Augment or enhance current efforts as appropriate. Monitoring programs should be designed for the following systems: aquatic and riparian (augment National Water-Quality Assessment Program); truly terrestrial; marine (continental margins).

B. *Spatial Distribution of Biological and Physical Attributes.* Develop a national spatial database as a repository and clearinghouse for geo-referenced biological, chemical, and physical data (existing and newly acquired). The database should be developed at an appropriate scale for determining geographic distributions of species and communities and the physical and chemical factors that influence distribution. The database can be used to track ecological changes, define critical conservation needs, and test predictive models for species distribution and ecosystem evolution.

C. *In-Stream Flow Methodologies.* Develop in-stream flow methodologies that address local hydrologic and physiographic conditions and the various uses of streams and rivers. Implementation steps include: identifying basic data needs; identifying various uses of streams and rivers (e.g., water supply, habitat protection, flood control, recreation); reviewing existing methodologies; developing new regional methodologies as necessary; designing monitoring programs to assess success or failure of various methodologies; modifying methodologies on the basis of monitoring results. ■

Workshop Participants

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Cheryl Ann Butman, *Woods Hole Oceanographic Institute*
Sarah Gerould, *U.S. Geological Survey*
David Graber, *National Biological Service*
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David Hart, *Academy of Natural Sciences*
John Haugh, *Bureau of Land Management*
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Kenneth Williams, *U.S. Fish and Wildlife Service*
E-an Zen, *University of Maryland*

This series of workshops was supported in part by contributions from the Exxon Corporation, the Campini Foundation, the Bullitt Foundation, the Minerals Management Service, and Michel T. Halbouty.

1997 John C. Frye Environmental Geology Award

In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. The award is a $1000 cash prize from the endowment income of the GSA Foundation's John C. Frye Memorial Fund.

The 1997 award will be presented at the autumn AASG meeting to be held during the GSA Annual Meeting in Salt Lake City.

Criteria for Nomination

Nominations can be made by anyone, on the basis of the following criteria:

(1) paper must be selected from GSA or state geological survey publications, (2) paper must be selected from those published during the preceding three full calendar years, (3) nomination must include a paragraph stating the pertinence of the paper, (4) **nominations must be sent to Executive Director, GSA, P.O. Box 9140, Boulder, CO 80301. Deadline: March 31, 1997.**

Basis for Selection

Each nominated paper will be judged on the uniqueness or significance as a model of its type of work and report and its overall worthiness for the award. In addition, nominated papers must establish an environmental problem or need, provide substantive information on the basic geology or geologic process pertinent to the problem, relate the geology to the problem or need, suggest solutions or provide appropriate land use recommendations based on the geology, present the information in a manner that is understandable and directly usable by geologists, and address the environmental need or resolve the problem. It is preferred that the paper be directly applicable by informed laypersons (e.g., planners, engineers).

1996 Award Recipient Named

The 1996 award will be presented at the GSA Annual Meeting in Denver to Steven Slaff for his report "Down-to-Earth Series 3, Land Subsidence and Earth Fissures in Arizona." The report gives scientifically sound geologic detail of an increasingly serious environmental problem which is applicable to many parts of our nation and is easily understood by laypersons.

GSAF UPDATE

Robert L. Fuchs

News of the Second Century Fund Membership Campaign

Past President Silver Leads Cordilleran Section

Former GSA President Leon T. Silver has replaced William R. Dickinson as Second Century Fund chair for the Cordilleran Section. Dickinson will be out of the United States for a considerable time during the next two years, which precludes giving the Section campaign the time it requires. Silver has recently retired from his position as the W. M. Keck Foundation Professor for Resource Geology at the California Institute of Technology and as a result will be able to devote time to the membership campaign during the coming months.

Silver was deeply involved in establishing the Foundation, pointing out as a Councilor and Budget Committee Chair as early as 1976 that GSA's financial reserves, in its second century, needed to be increased and that new endowment funds should be obtained. During his term as President in 1979, he actively promoted and supported the Centennial Development Committee, the forerunner of the GSA Foundation. Silver was also instrumental in convincing his older brother Caswell to serve as the founding chair of the Foundation and to provide important seed money by making the first major individual contribution.

One of our science's most active and visible geologists, Silver has been a participant in countless committees, working teams, and advisory groups of many national and international organizations, including the National Academy of Sciences, National Research Council, NASA, and National Science Foundation. Although his long record of service spanning nearly 35 years already ranks him among the most dedicated of GSA's members, Silver continues to demonstrate his strong sense of responsibility for the well-being of GSA and geology. In a recent discussion with President Eldridge Moores, Silver expressed the view that GSA Past Presidents should play a more active role in the Society. Now he has backed up his words by assuming this important Cordilleran Section job. Moores noted that, "When I asked Lee Silver how the experience of Past Presidents could be best utilized, he replied 'in raising money.' By taking the Cordilleran SCF chair, he is practicing what he has preached for over 20 years, to GSA's lasting benefit."

Timing is Everything—Make Your SCF Pledge Soon

We hope that if you are not already a contributor to the membership campaign, you will seriously consider a pledge this year. There is also good reason to do this *before* or *at* the Denver annual meeting. Donors to the membership campaign at the $250 or higher level are eligible for a drawing that will be held during the meeting. A number of valuable prizes will be awarded, topped by one of GSA's popular GeoHostels. Other awards include books, software, and journal subscriptions. This array of gifts has been made possible through the generosity of annual meeting exhibitors, including Blackwell Scientific Publications, Earth'nWare, Mountain Press Publishing Company, Numerical Algorithms Group, Kalmbach Publishing, and University of Chicago Press. So don't put off until tomorrow what you should do today. ■

Next Pardee Coterie Meeting is October 30

The Pardee Coterie, the gathering of GSA Foundation planned givers, will meet again this year during the annual meeting. The 1996 breakfast meeting will be held at the venerable Brown Palace Hotel, a hostelry that, like GSA, is now in its second century. The date is October 30 at 9:00 a.m. GSA President Eldridge Moores will speak about current Society developments, and Education Coordinator Ed Geary will cover the many dynamic aspects of the SAGE program and the newly developing Earth-Space Center.

The Pardee Coterie is open to any who have made planned gifts to GSA. This includes bequests, charitable remainder trusts, charitable gift annuities, and the Foundation's Pooled Income Fund. Contact the Foundation office by phoning or sending an E-mail or the accompanying coupon to get further information. ■

It's Really Not Too Early To . . . .

It's really not too early to think about maximizing your 1996 charitable deductions, and minimizing your income taxes. Next month's GSAF Update will deal in more detail with this topic, but a few ideas may be helpful now. If you have securities in which you have capital gains, think about donating the securities rather than cash. You'll save taxes by doing this. If you have securities in which you have capital losses, consider selling the securities and donating the cash. In this way you will realize the losses, which will lower your taxes. If you do not usually itemize deductions, give thought to bunching your deductions in the current year to increase 1996 deductions above the standard threshold. This can be done by pre-paying before year end where possible such deductible items as state income taxes, property taxes, and charitable gifts, including next year's pledges. Finally, look around for an unused asset that might be donated to charity this year, such as a life insurance policy that has outlived its original purpose, or an item of real or personal property that is unutilized. ■

Visit GSAF on the World Wide Web

The GSA Foundation can now be found within the GSA home page on the World Wide Web. You can find us at http://www.geosociety.org by clicking on the GSA Foundation link. You will learn how you can help advance the science of geology through a gift to the Second Century Fund or the Foundation's annual campaign. Or learn about various planned giving instruments, if you are considering making a larger gift or looking for retirement income. You can even send us a direct E-mail message, right off the Web! Julie Wetterholt, Second Century Fund Campaign Coordinator, commented, "The Foundation is very pleased to have a place on the Web. We think the members will appreciate a quick and direct access to Foundation information, especially details on the current capital and annual campaigns, not to mention the more complicated planned giving instruments."

Director of Development Appointed

Valerie G. Brown has been appointed the GSA Foundation's Director of Development and joined the headquarters staff at the beginning of October. She will have responsibility for much of the Foundation's fund-raising activity, including the Second Century Fund, the annual campaign, and planned giving.

A Denver resident, Brown was Director of Grants and later Senior Development Officer for the University of Colorado Foundation at the Health Science Center Campus. Over a 12-year period she was engaged in a broad range of fund-raising, managerial, and administrative duties and was a key participant in a successful $77 million capital campaign. Previously she was employed in development work at the Craig Hospital Foundation in Englewood, Colorado. Brown has worked as Personal Trust Officer at the former United Bank of Denver and has also been in the private practice of law. She has a B.A. degree from the University of Colorado and a J.D. degree from the University of Denver College of Law.

Special thanks to those Senior Fellows who have relayed to the Foundation some of their most memorable early geological experiences. We will have a memory board with these quotations at the Senior Fellows Reception in Denver.

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Meeting Abstracts for Denver '96 Set New Record

Jim Clark
GSA Production and Marketing Manager
Mark Duvall
GSA Information Services Manager

More abstracts were submitted for Denver '96 than for any previous meeting in GSA's history: 2,870—a dozen more than the previous record of 2,858 submitted for Seattle in 1994.

GSA's new electronic abstract submission system on the World Wide Web, in use for the first time this year, may have accounted for some of the increase. A total of 1,257 abstracts came via that system, proving it to be more popular than we had expected: 44% of submissions were electronic, and 56% came on the familiar, preprinted paper forms.

Although the Web system was new and somewhat exotic, it apparently was relatively trouble-free for most users. Many commented that it was more convenient and less expensive than the express services so many have used in the past.

One thing did not change this year: most abstracts—including Web submissions—were sent and received on deadline day and the day before. Those who waited until the last minute to send over the Web had few alternatives left if anything went wrong. A few authors, in spite of repeated trying, simply could not make the Web system work; in these special cases, GSA extended the deadline, making it possible for these authors to get their material into the system.

All of the 300 or so E-mail messages that peppered the processing staff at deadline time were answered promptly. Most were concerned whether GSA had received an abstract, some asked for corrections to content, three complained about the number of words permitted on both the electronic and paper forms, and several sent thanks and compliments on the system.

Planning for the 1997 abstract submissions is already underway, with improvements planned in the electronic system, based on user comments and our experience. The abstract numbers and names of the senior authors of all accepted abstracts—electronic or paper—will be posted on the Web, about two weeks before the traditional acceptance notices are mailed.

You'll be able to search this list quickly, and the data will be updated with individual session information as quickly as that is available. This should be of help to those needing early information for airline reservations or other planning.

Changes are on the way for the paper abstract forms, too. For 1997 there will be two different paper forms: one for use for any GSA Section meeting (distributed in September 1996); the other for use for the Salt Lake City Annual Meeting (to be distributed in spring 1997). The two forms will *not* be interchangeable. ■

ABSTRACTS SUBMITTED TO GSA ANNUAL MEETINGS

Year	City	Qty
1996	Denver	2,870
1994	Seattle	2,858
1988	Denver Centennial Meeting	2,585
1991	San Diego	2,526
1993	Boston	2,502
1987	Phoenix	2,340
1995	New Orleans	2,206
1989	St. Louis	2,042
1990	Dallas	1,952
1992	Cincinnati	1,867
1986	San Antonio	1,865

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1,800 Web Browsers?!

Some 1,800 versions of Web browsers, the software tool required to send a Web abstract, are out there. The good news is that GSA's first Web abstract form was widely usable, in spite of the many and varied quirks inherent in that variety.

Those using a current or recent version of the prominent browsers (Netscape, Microsoft Explorer, Mosaic), seemed to have the least trouble with our Web abstract form. But many older browsers do not display tables, forms, and other features required for an interactive form, and some Internet service providers handle Web forms poorly. Other than that, the problems were relatively few.

The most common problem was unexpected: some authors lost their live connection to the Web while they were completing our form. When they tried to "send," nothing happened—except that usually the form went blank again. We were caught off guard—this problem occurs because of conditions on the user's side and has nothing to do with GSA's system. The problem is a simple one, but not widely understood. When a user accesses a Web form, the user's computer and browser actually make a copy of the form, storing it either in memory and/or on the hard disk. As long as the user's Web connection remains live, clicking the "send" button on the form will successfully speed the abstract to GSA because the browser has an open line for transmission. If the connection has been lost, there is nowhere for the data to go.

Web connections can be interrupted for several reasons, all but one of which—a crash of GSA's system—are beyond our control. Since GSA's system never crashed this year, if this happened to you here are some possible reasons: (1) your browser's optional "time-out" setting may be set too low; (2) if you're on a network, your system administrator may have assigned you low connect-time limits; (3) your PC or Web server may have crashed, or may have disconnected you because of other user demands; electrical power may have failed; and so on. The loss of the Web connection is transparent to most users, especially novices, because the form continues to appear on screen, even though the computer is then reading it only from memory or disk cache, not from a working, live connection. In this situation, when the send button is clicked, the user sees nothing; there is *no* immediate confirmation from GSA with an assigned abstract number to assure you that all's well. Even more frustrating, the data laboriously entered on the form usually disappears. The only recourse is to check the "time outs" in your browser, and perhaps with your system administrator, and try again.

Another problem had to do with E-mail acknowledgments to authors sometimes being garbled, or including characters authors did not use. This problem was due to three things. First, because of variations in computer platforms and user skills, many abstracts included nonstandard characters. At GSA, we were programmed to filter out those that we knew about. But about 20 new ones cropped up that we had to incorporate into our filters on the fly. Second, E-mail technology is somewhat archaic and sometimes garbled parts of our messages, adding to the confusion. Third, we tried to embed a shortened version of the abstract title in our E-mail confirmations, but authors didn't understand why their full title wasn't included.

The last major problem was due to a characteristic of the text boxes in our Web form. For technical reasons, we were unable to provide "line wrap" in those boxes—that feature that formats a paragraph to look like a paragraph. Rather, when typing or pasting into text boxes, users found that each paragraph of text appeared in a long line. Some tried to insert manual carriage returns and other formatting characters, all of which had to be filtered out. Text properly entered, without user formatting, was quickly and accurately formatted by our system. We're looking for a technical answer that will let us incorporate line wrap in our text boxes.

In most of these situations, people want to see what they are accustomed to seeing in other media. It's important to realize, however, that the Web is not a format-oriented medium, but a content-oriented one. Formatting is always controlled on the receiving end, with settings for most format characteristics being set within the browser in use. In 1997, we'll do our best to inform our users of any of these problems that cannot be resolved.

How Many Words?

How many words fit into a paper abstract form? How many into a Web abstract form? The 250 words "acceptable" in an abstract apparently was a limit suggested in 1968 by the ad hoc Committee on Long-Range Planning of Annual Meeting Programs. For many years, the box on the paper abstract form was designed to hold about 300 words in 12 pitch typewriter type. With the appearance of laser printers and computers, we suggested that 11 point laser type be used, but not less than 10 point. Most abstract submitters used 10 point, getting from about 310 words to as many as 350 into the box.

We revisited this issue as we designed the Web abstract form. Studying a sampling of abstracts from 1995 to determine what people were doing, we found these averages: about 400 words per abstract, about six characters per word (plus a blank space for each word), and most type sizes ranging from about 8 points up to 10 points. Those type sizes result in final printed copy of from 4.8 point to 6 point type, because we paste abstracts to oversized boards and reduce the pages to 60% of original size. In experiments, we found that the number of words we could fit onto a paper form varies tremendously with minor alterations in the space between characters and between lines, both of which are features provided by most modern-day word processing software. But we must live by the economics of the still-dominant paradigm of ink on paper. Abstracts sent via the Web are printed at GSA at a more readable 11 points, which after reduction to printing size is only 6.6 points, barely readable by many. The size of the type placed in the boxes on our Web form makes no difference in this equation because all are printed at GSA; only character counts matter.

So we settled on a limit for the Web form as follows: title box: 336 characters; author-data box: 2,000 characters; abstract text box: 2,504 characters; total: 4,840 characters. On the basis of an average of seven characters per word plus one between-words space, that is, about 600 words possible in all three boxes.

This count is about double the words possible within the paper form's box, if you use 10 point Helvetica type, and standard spacing.

If your experience differed from our conclusions, we would like to reproduce the circumstances of your setup exactly to learn what factors were responsible. Contact J. Clark at jclark@geosociety.org.

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LETTERS TO THE EDITOR

USGS RIF

About one-quarter of the staff of the Geologic Division of the U.S. Geological Survey was fired in October 1995, in a Reduction in Force, or RIF, which has been discussed in three prior reports in *GSA Today*. The article by Survey management in the November 1995 issue mostly described a theoretical process which, although legally mandated, was largely circumvented. An excellent description of the actual process, signed by two lawyers representing 30 appellants against the RIF, appeared in the April 1996 issue. The pro-management statement in the July 1996 issue by outsider M. T. Halbouty contained many misconceptions.

The Geologic Division had for some years been increasingly squeezed between rising fixed costs and a flat budget, and downsizing was required to free funds for essential expenses. Voluntary induced resignations and retirements in late 1994 and early 1995 took 400 people (including me) off the starting roster of about 2600 and corrected the fiscal imbalance. Nevertheless, about 350 permanent employees and all 250 nontenured employees were fired in October 1995, bringing the roster down to about 1600, 62% of what it had been in early 1994. The Division now (August) has a very large surplus of funds which it is attempting to commit before Fiscal Year 1996 ends on September 30.

Civil Service RIF regulations require that nontenured employees be fired outright but that permanent employees with like skills compete with each other for the decreased number of jobs which any of them should be able to learn to perform within a few months. Survey managers circumvented this by classifying nearly all permanent scientists into one-person categories so as to permit the firing of almost any individual by abolishing his extremely specific job. One can argue about how many categories of specialists and generalists Survey scientists properly represent, but much interchangeability exists within disciplines, and the claim that no one who was fired could have learned to do the work of anyone who was not is false. For example, the largest group of those fired were general geologists, many of whom could have quickly handled the jobs of many of those who were retained. The skills and principles of geologic fieldwork in large part can be readily applied to new areas. Most young Survey field geologists were assigned a quadrangle each to map in Kentucky when a state co-op project started there in the 1960s, and they did the jobs quickly and competently although they began with no local knowledge.

The RIF took place simultaneously with wrenching reorganization away from an emphasis on small geoscience research projects to an emphasis on geotechnical megaprojects, micromanaged from above, thought to be more saleable to politicians. In-progress projects representing thousands of man-years of research were scrapped without plans for salvage. The pre-RIF managers planned the reorganization (which abolished most of their own administrative jobs) and outlined the new megaprojects. They then assigned personnel to be retained, including themselves, by name ("staffing plan"), to the new projects. They defined the description of each new job as the old job description of a retainee even if the new job would bear little or no similarity to the old. Scientists omitted from the staffing plan could not compete for the *new* jobs because their jobs were deemed different from the *old* jobs held by the retainees, and were fired.

Scientists were retained or fired mostly by the 25 outgoing branch chiefs, each using whatever arbitrary and uncoordinated criteria he wished, subject to extensive pulling ("add-backs") and pushing from above. Some chiefs flagrantly indulged favoritism and spite, some tried to retain the most productive scientists and those best suited to the new tasks, and the rest were somewhere between. Most strongly favored their own specialties, localities, and friends, regardless of relevance to the new projects. Examples abound of incompetent cronies retained, and of excellent scientists fired because they disagreed, personally or professionally, with supervisors, or because they were in a place, specialty, or age group different from that of a branch chief.

Proof that the RIF was corrupt is given by the way managers treated themselves. Before the RIF, there were about 75 line and staff administrators ranking as branch chiefs and above. Perhaps 50 of the 75 had gone into management not as productive scientists rotating through administrative chores but rather as failed or burned-out scientists seeking high pay without pressure to do research. About 2/3 of these upper-level managerial positions, including those of all branch and office chiefs, were abolished in the reorganization, leaving their occupants theoretically exposed to automatic RIFing, but only one of the 75 was fired. I know of only three who were fired from a similar number of administrators at the lower level of assistant branch chiefs and their parallels. All others found themselves safe shelters, mostly in scientific jobs in which they retain their high administrative salaries in nominally lower-level positions. The job descriptions of managers moving back to science for shelter listed not what they were currently doing (as was required for the fired scientists) but instead listed a selection from what they had earlier done as scientists. Many of them had no experience in the fields of their new jobs, which falsifies the purported all-scientists-are-unique basis for the RIF.

Morale has been shattered among the survivors. Cynicism and apprehension, and discouragement over abandoned research, are widespread.

Warren Hamilton
Golden, CO

Geological Survey of Canada—Cost Recovery Concept and Mandate

For more than 150 years the GSC has led the way in fundamental and applied geologic research in Canada with a dedicated staff doing long-term regional projects. These included drilling of the first gas well in western Canada, the recognition of the economic importance of the tar sands, and identification of many major mineral deposits.

Officers of the GSC such as Logan, Dawson, and McConnell have been pioneers in the exploration and the opening up of Canada. These pioneers and those that followed them have established Canada as having one of the best geological surveys in the world. They have all worked under administrations that nurtured long-term regional research, and under leaders with vision and dedication that provided the environment that allowed them to establish outstanding reputations in the geosciences.

The high standards of scientific excellence and relevance which characterized the Geological Survey of Canada over much of its history were based on: long-term scientific programs, which addressed fundamental and applied aspects of geologic research in Canada, in cooperation with industry, provincial governments, and universities; [and] government funding for laboratory and field-oriented projects to achieve these goals for the use of Canadians, including industry. This concept has been scrutinized by a number of industrial and academic committees over the past years, all of which have been most favorable, praising the Geological Survey of Canada as a research institute within Canada and internationally for its excellence in fundamental and applied research, and for the efficient means by which this research was made public.

Letters *continued on p. 18*

Letters *continued from p. 17*

Presently the Survey's long-term regional mandate is under serious attack, with the focus shifting towards short-term single-client–oriented projects under programs such as the Industrial Partnership Program (IPP) or programs of cost recovery. The current management is much more political and focuses on the short-term expediency of downsizing and does not show a long-term vision for Canada or the Survey.

Implications of the "client-oriented" and "cost recovery" concepts raise serious concerns as to the future role of the GSC in addressing the needs of Canada as a whole and providing independent geological research for the benefit of Canadians.

Client-oriented Projects. It is obvious that industry-oriented projects will have only little relevance to long-term strategies, since they are governed by the legitimate interest of the companies to make a profit in areas that are close at hand. It seems clear that client-oriented projects will only distract from and hinder the accomplishment of long-term regional studies for the long-term benefit of Canada.

Cost Recovery. The cost recovery concept is essentially a subsidized entry into private enterprise, whereby the Geological Survey of Canada competes with the consulting sector, while salaries, overhead, equipment, etc., for the most part are publicly funded. As such, this approach must be perceived to be highly unethical. It also hinders, as in the case of short-term and client-driven projects, the ability to focus on the basic mandate of the GSC, namely to conduct independent research which serves the need of Canada as a whole.

In view of the above and the current management having failed to address the major issues, I recommend: To assemble a panel of senior scientists from inside and outside the organization (industry, universities, provincial surveys) to review its mission and goals, especially in regard to the cost recovery concept and the role of a federal geological survey within Canada.

W. Kalkreuth
Calgary, Alberta T2L 2H3, Canada

Why *GSA Today*?

Michel Halbouty's letter published in the July 1996 *GSA Today* raised a significant issue—what is the purpose of this publication? Is it exclusively for members of GSA, or is it also for distribution of news and information important to the larger geoscience community? If the former, then it is reasonable to not allow nonmembers of GSA to publish letters in it.

However, I think that question was answered in favor of the second position when the Society decided that *GSA Today* will not only go to all GSA members but to subscribers, as well as to libraries. The journal has been serving a useful function in that role, and it should remain that way.

The letter from Mary Dryovage and Jeff Rush (*GSA Today,* April 1996) that Mike Halbouty found irksome conveys messages of importance to those concerned with the well-being of the USGS—and that is a very large group, as Mike pointed out. Mike was vexed that "the GSA permitted the publication of such a one-sided, critical letter." Perhaps Mike did not note that the letter was responding to an unsigned article (*GSA Today,* November 1995) that presented the USGS side of the Reduction-In-Force event. In his prefatory note to that first letter, Don Davidson had set out the reason for its publication very clearly.

I trust the Letters section of *GSA Today* will continue to be open to all who have useful information to convey, regardless of their professional status or membership in the Society.

E-an Zen
Reston, VA 20191 ■

GSA Congressional Science Fellow Named for 1996–1997

Tamara J. Nameroff has been chosen as the eleventh GSA Congressional Science Fellow. She will work as a special legislative assistant on the staff of a committee or member of the U.S. Congress from September 1996 through August 1997.

Nameroff's goals as a Congressional Science Fellow are to promote environmental policies that are scientifically defensible and to work to ensure that Congress recognizes the influence of science and technology policies on large sectors of the U.S. economy. She expects to draw on her academic experiences in analytical chemistry and oceanography, as well as her work in industrial and regulatory agency settings. "I am especially interested in the debate on the national policy on research and development, the links between R & D and economic growth, and the relationship between environmental policies and the U.S. economy," Nameroff says.

Nameroff received her Ph.D. in environmental and analytical chemistry in 1996 from the University of Washington and her B.A. in chemistry, magna cum laude, from Carleton College, Northfield, Minnesota. Among her research interests and experience are trace metal geochemistry; paleoceanography; tracers of paleocean circulation and preservation of organic matter; diagenesis of organic matter; aquatic chemistry; novel trace metal analytical techniques; flow injection analysis; and federal environmental science and technology policies.

The Fellowship

The Congressional Science Fellowship gives a geoscientist first-hand experience with the legislative process and the opportunity to view science policy issues from the lawmaker's perspective. At the same time, the Fellow assists in the analysis of public policy issues by providing scientific and technical expertise.

Funded by GSA and by a grant from the U.S. Geological Survey, the fellowship demonstrates the value of science-government interaction and enhances the involvement of the earth science community in the public policy arena. The program places highly qualified, accomplished scientists with the offices of individual members of Congress or committees for a one-year assignment. Fellows perform in much the same way as regular staff members; they have the opportunity to be involved in varied legislative, oversight, and investigative activities. They offer their special knowledge, skills, and competence for the opportunity to acquire experience and the chance to contribute to the formulation of national policy.

Tamara J. Nameroff

To prepare for their assignment, Fellows attend a two-week orientation conducted by the American Association for the Advancement of Science. Fellowship requirements include exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside the Fellow's particular area, and a strong interest in working on a range of public policy programs. The Fellow reports periodically to the GSA membership and to the U.S. Geological Survey during the one-year period. ■

The Geological Society of America

Congressional Science Fellowship 1997–1998

The Geological Society of America is accepting applications for the 1997–1998 Congressional Science Fellowship. The Fellow selected will spend a year (September 1997– August 1998) in the office of an individual member of Congress or a congressional committee for the purpose of contributing scientific and technical expertise to public policy issues and gaining first-hand experience with the legislative process. The American Association for the Advancement of Science conducts an orientation program to assist the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

Criteria

The program is open to highly qualified postdoctoral to mid-career earth scientists. Candidates should have exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside the Fellow's particular area, and a strong interest in working on a range of public policy problems.

Award

The GSA Congressional Science Fellowship carries with it a $42,000 stipend, and limited health insurance, relocation, and travel allowances. The fellowship is funded by GSA and by a grant from the U.S. Geological Survey. (Employees of the USGS are ineligible to apply for this fellowship. For information about other programs, contact AAAS or the Geological Society of America.)

To Apply

Procedures for application and detailed requirements are available in the geology departments of most colleges and universities in the United States or upon request from: Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

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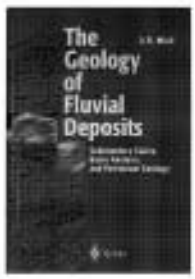

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Acid trauma at the Cretaceous-Tertiary (K/T) boundary in eastern Montana: Comment and Reply

COMMENT

J. David Archibald
Department of Biology, San Diego State University, San Diego, CA 92182-4614

In his recent article hypothesizing about the occurrence of acid rain at the Cretaceous-Tertiary (K/T) boundary in eastern Montana, Retallack (1996) stated that "acidic trauma may explain the transition in Montana from … herbivorous to insectivorous vertebrates." There is no such transition recorded in the vertebrate record across the K-T boundary. The authors Retallack cited (Sheehan and Fastovsky, 1992) did not make this claim and did not discuss the vertebrates that appeared after this transition. Of the 107 vertebrate species now well-documented in the Hell Creek Formation, a minimum of 52 (or 49%) survived. Of the 55 species that disappeared (either becoming extinct or migrating with environmental change), 29 were carnivorous or insectivorous, 14 were omnivorous, 11 were herbivorous, and one was a filter feeder. Of the 52 species and relatives that survived, 45 were carnivorous or insectivorous, six were omnivorous, and one was a filter feeder (tabulated from Archibald, 1996). Mammals show the greatest evolutionary change among vertebrates through the K-T transition. Of the 18 species known to appear in the interval just after the K-T boundary in Montana, eight were herbivorous, nine were omnivorous, and one was carnivorous or insectivorous (Lofgren, 1995). Thus, if we can say anything, it is that more herbivores became extinct than omnivores, and the least extinction occurred among carnivores and insectivores. However, new species of herbivores and omnivores appeared, resulting in no net transition to insectivores.

It is clear from modern case studies that aquatic vertebrates suffer most from acid rain (Cox, 1993). As pointed out by both supporters (D'Hondt et al., 1994) and doubters (Weil, 1994a, 1994b) of the acid rain scenario, aquatic vertebrates show among the highest survivorship—exactly opposite acid rain predictions. Retallack's suggestion that "calcareous smectitic soils" may have buffered the aquatic systems does not accord with what is known of modern lakes that remain acidic even though they are underlain by limestone (Pollman and Canfield, 1991). Further, Retallack was assuming that the calcareous component of the rocks that we see in the field is the same as that of the original soils. It is more likely that these calcareous components are of diagenetic origin, deposited from ground waters long after the soil formed and was buried. Even more troubling is that we don't know the lateral extent of the paleosol types and compositions that Retallack discusses, as they are from a single stratigraphic section in eastern Montana.

What we know of the reaction to acid rain of extant vertebrates coupled with the K-T vertebrate record provides no support to the kind of acid rain scenario proposed by Retallack (1996).

REPLY

G. J. Retallack
Department of Geological Sciences, Univeristy of Oregon, Eugene, OR 97403-1272

My position on differential extinction across the K-T boundary was merely to agree with previously published views (Sheehan and Hansen, 1986; Sheehan and Fastovsky, 1992) that insectivores were least affected among land animals. I am pleased that Archibald agrees with this, and apologize for the misleading terseness of my paper (Retallack, 1996). Large carnivores and herbivores were very hard hit. The dominant latest Cretaceous, duckbill and ceratopsian dinosaur herbivores had specialized dental batteries with no parallel among Late Cretaceous or early Paleocene mammals that Archibald interprets as herbivores. Herbivore extinction is an expectation of a life crisis that involved acidification that would brown leaves. Another expectation is the transition observed in K-T vegetation from evergreen dicots to deciduous dicots and conifers (Retallack, 1996). Yet another indication of acid trauma is the heavy extinction of freshwater molluscs across the K-T boundary in the northern Great Plains states (documented by Hartman, 1996). Aquatic vertebrates were less affected, as Archibald emphasizes, but this does not mean there was no acid. The bioassay implied by decimation of aquatic molluscs, but not aquatic vertebrates, is that ground-water pH depression was between 5.5 and 4. My proposal for atmospheric scrubbing and soil buffering was to explain this modest acidification compared with the dire predictions of some impact scenarios and from observed leaching of the boundary bed.

Much of the carbonate and smectite in latest Cretaceous paleosols of Montana can be shown to have originated in soils, because of petrographic observations of diffuse micritic nodules replacing clay skins and grains and filling etch pits in grains (McSweeney and Fastovsky, 1990, Fig. 6). There also are minor detrital grains and burial cements in sandstones (Retallack et al., 1987; Retallack, 1994). Other evidence for pedogenic origin of most of the carbonate and smectite is the remarkably uniform composition and appearance of the clayey paleosols in the Hell Creek Formation from Buffalo, South Dakota, to Marmarth, North Dakota, to Jordan, Montana—some 400 km. Archibald's implication that my Bug Creek and Hell Creek sections are atypical is at variance with my observations and those of others (Fastovsky and McSweeney, 1987; McSweeney and Fastovsky, 1987).

Archibald's comment takes what I consider the simplistic view that acidification is either present or not, when there are widely differing degrees of acidification, which I calculated. Weathering is a process of acidification and every buffer has a finite capacity. Although Florida has much carbonate bedrock, acidic seepage lakes occur in areas dominated by base-poor soils (Ultisols, Spodosols: Pollman and Canfield, 1991), very different from the base-rich latest Cretaceous paleosols of the Hell Creek Formation. Given my agreement with Archibald on selective extinction of acid-prone organisms of latest Cretaceous ecosystems, the question is not whether there was acidification at the K-T boundary, but how much.

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Comment and Reply *continued on p. 22*

Dalziel Named to New GSA International Secretariat

Ian Dalziel

A familiar presence at GSA meetings and functions, Ian W. D. Dalziel has added an appointment to a three-year term as GSA International Secretary to his credits. In his nearly 40 years of geological experience, Dalziel has been involved in international activities spanning the globe from his native Scotland to the Antarctic. At present, Dalziel is senior research scientist and associate director of the Institute for Geophysics at the University of Texas at Austin, and professor in the university's Department of Geological Sciences.

The International Secretariat is a new GSA endeavor with the broad purpose of enhancing the international character of the Society by encouraging collaborative research among countries worldwide, establishing GSA memberships and perhaps sections on foreign soils, and promoting symposia and theme sessions on international and global topics at GSA meetings, as well as publication in GSA journals by international geologists. The choice of Dalziel to launch this effort is a natural, because of his extensive experience in working overseas on cooperative projects and running international meetings and field trips.

For many years Dalziel specialized in the study of orogenic and continental break-up processes in the Andes and West Antarctica, and the tectonic evolution of the southern continents and ocean basins. Although still involved in cooperative projects aimed at determining the nature of active tectonism in the Scotia arc region and the sub-ice structure of Antarctica, he now devotes much of his time to studying the long-term tectonic history of Earth, including testing new hypotheses of pre-Pangea geography with his colleagues and students.

In addition to being a member of a number of international societies and committees, Dalziel has been named a Fellow of GSA and of the Sociedad Geológica de Chile. He is a recipient of the Murchison Medal of the Geological Society of London and was elected a Miembro Correspondiente of the Asociación Geológica Argentina and a Fellow of the Royal Society of Edinburgh. Dalziel is the Delegate to the Scientific Committee on Antarctic Research of the International Union of Geological Sciences.

As an advocate of GSA's involvement in global earth science, Dalziel will be lead convener of the symposium "Iapetus" to be sponsored by the International Division at the 1997 GSA Annual Meeting. This should attract a significant number of European and South American earth scientists as, according to Dalziel, "the early Paleozoic ocean off North America's present eastern margin is the key to geography, sea level, and environments of a biologically critical time." Last year, he was co-convener of GSA's Penrose Conference on the Argentine Precordillera in San Juan, Argentina. The meeting was co-sponsored by the Asociación Geológica Argentina, the Asociación Paleontológica Argentina, and CONICET Argentina.

As Don Davidson, GSA Executive Director, states about this new position and the choice of Dalziel to fill it, "Ian's background and experience are what we need to successfully launch this enterprise. We are entering uncharted waters here, and I am confident that working together with Ian and with the International Division, GSA can generate a program that will benefit the science as well as the Society and the International Division." ■

Comment and Reply
continued from p. 21

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GSA Division News

Divisions will be recognizing the following individuals at the 1996 Annual Meeting in Denver for their service to the Division and/or contributions to the geological sciences.

Hydrogeology Divison
John M. Sharp, Jr.
Distinguished Service Award
Paul A. Witherspoon, Jr.
Distinguished Service Award
Mark Person
1997 Birdsall-Dreiss Distinguished Lecturer

Quaternary Geology and Geomorphology Division
Robert P. Sharp
Distinguished Career Award

For a listing of other award recipients to be honored at the Denver meeting, see page 25 of July 1996 *GSA Today.*

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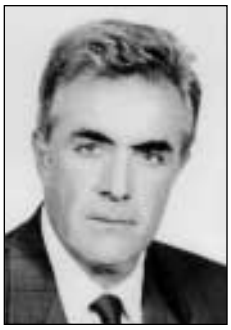
GSA HEADQUARTERS (800) 472-1988, EXT. 131.

Three Named Honorary Fellows

Three eminent European scientists have been named Honorary Fellows by the GSA Council.

Alfonso Bosellini

Alfonso Bosellini's work on carbonate stratigraphy and tectonics of the Alpine-Mediterranean fold belts has inspired established geoscientists and students alike.



Alfonso Bosellini

Born in Mantua, Italy, in 1934, Bosellini earned his degrees at the University of Padua. He held postdoctoral fellowships in the United States, at the Johns Hopkins University and Scripps Institution of Oceanography. His wide interests in structure, stratigraphy, and sedimentology led him to study the Alps, the Dolomites, Apulia, Sardinia, Somalia, Tunisia, and Ethiopia. He is currently head of the Department of Geology at the University of Ferrara, as well as president of the Geological Society of Italy and the International Assocation of Sedimentologists.

Bosellini has published several landmark papers, most notably on the relations of block faulting, volcanism, and carbonate platform growth in the tectonic evolution of the Dolomites, and on progradation geometries of carbonate platforms. His publications include five books, one of which is a widely used earth science text in Italian high schools.

Bruno D'Argenio

Work by Bruno D'Argenio on the carbonate platform and basin morphology of the Apennines and Sicily has led to a better understanding of central Mediterranean paleogeography.

Bruno D'Argenio

D'Argenio was born in Benevento, Italy, in 1935. He earned degrees in Naples and Rome and held a postdoctoral fellowship at Princeton University. His research interests include marine and nonmarine geology of the peri-Adriatic region, sedimentology and stratigraphy of carbonate rocks, the history of geology, especially in regard to sedimentary geology, and the relation of carbonate cycles to orbital forcing. He has taught and done research in Somalia and Angola. He has been director of the Istituto di Geologia e Geofisica and is currently director of the Istituto di Ricerca, Geomare Sud of the Consiglio Nazionale delle Richerche, at the University of Naples. D'Argenio's publications include many written with scientists in other countries, an outcome of his field work with international colleagues.

Paul Tapponnier

Paul Tapponnier is widely considered to be the driving force in development of understanding of the active tectonics of Asia—especially the history of the India-Eurasia collision.

Paul Tapponnier

Tapponnier, a French citizen, was born in 1947. He earned degrees at the École Nationale Superieure des Mines de Paris and the Université des Sciences et Techniques du Languedoc at Montpelier. He was a visiting research fellow at the Massachusetts Institute of Technology and is distinguished visiting scientist at the Jet Propulsion Laboratory in Pasadena, California. His research interests include structure, tectonics, remote sensing, climate change, Tertiary metamorphism, and paleomagnetism as applied to the Mediterranean, Himalayan Asia, and north and east Africa. He is currently director of the Laboratoire de Tectonique, Mécanique de la Lithosphere at the Institut de Physique du Globe de Paris.

Tapponnier's long list of publications includes many papers written with students and colleagues at his laboratory. He is known for heading a dynamic team of scientists. ■

Call for Nominations

Mentors in Applied Geology

The Geological Society of America's Institute for Environmental Education is now soliciting nominations for the Roy J. Shlemon Mentor Program in Applied Geology. Funded by an endowment from Roy J. Shlemon, the Applied Geology Mentor Program bridges the gap between the applied and academic geology communities. The mentors are experienced geologists currently practicing in various fields of applied geology. Each mentor presents a one-day workshop for graduate and senior undergraduate geology students focusing on professional opportunities and challenges in the applied geosciences. Workshops may include lectures and/or field and laboratory exercises, depending on the technical specialty of the mentor, as well as discussion of "practical problems" in applied geology such as running a business, marketing, hiring and firing, and legal and regulatory challenges.

Mentors receive an honorarium for conducting the workshop, in partial recognition of their outstanding contribution to the applied geosciences. Up to six Shlemon Mentor workshops will be held each year, in conjunction with the six GSA section meetings.

The 1996 Roy Shlemon Applied Geology Mentors are
James E. Slosson, Van Nuys, California—Rocky Mountain Section
William R. Cotton, Los Gatos, California—Cordilleran Section
Michael Hart, San Diego, California—Cordilleran Section
Dean Lewis, Ames, Iowa—North-Central Section

Criteria for Nomination

Mentors should be highly regarded practitioners in the applied geosciences. Preference will be given to nominees who emphasize one of the following specialties: Quaternary geology, geomorphology, environmental geology, engineering geology, geoarcheology, and hydrogeology. Nominees should have at least 15 years of experience outside of academia and government and should be working actively in an applied field. Nominees should also be active in the geological community, preferably with a record of presented or published papers.

Nominations should be in the form of a brief (one-half page) narrative summarizing the qualities and experiences of the nominee. This narrative may be supported by additional professional and biographical material. We request that nominators include their phone number and/or E-mail address.

Mentors will be selected by GSA section meeting committees from the pool of nominees.

Please send nominations to:
Roy Shlemon Applied Geology Mentor Program,
Institute for Environmental Education,
Geological Society of America,
P.O. Box 9140,
Boulder, CO 80301

GSA Division and Section Grants for 1996

June Forstrom, Research Grants Administrator

DIVISION RESEARCH GRANTS

Seven of the 12 GSA divisions offer grants for outstanding student research within the fields of the respective divisions. Recipients of these grants for 1996 are listed below. Two divisions offer other student awards: the Archaeological Geology Division awards a $500 student travel grant for attendance to present a paper at the GSA Annual Meeting, and the Planetary Geology Division awards two best paper awards for presentations at the annual Lunar and Planetary Science Conference. The three divisions that do not currently offer any awards to students are Geoscience Education, History of Geology, and International.

Archaeological Geology Division

The Archaeological Geology Division presented a best paper student travel award of $500 for attendance at the 1995 GSA Annual Meeting in New Orleans. Andrew H. Ivester of the University of Georgia received the award for his paper, presented in the Archaeological Geology Theme Session, "A Late Quaternary Paleoenvironmental Record from Sediments at White Paintings Rock Shelter, Tsodilo Hills, Botswana."

The Geological Society of America

Research Grants Program 1997

The primary role of the Research Grants Program is to provide partial support for research in earth science by graduate students at universities in the United States, Canada, Mexico, and Central America. GSA strongly encourages women, minorities, and persons with disabilities to participate fully in this grants program. Eligibility is not restricted to GSA members. New application forms are available each fall in the geology departments of colleges and universities offering graduate degrees in earth sciences. Forms are mailed to GSA Campus Representatives and department secretaries and chairpersons in the United States, Canada, and Mexico. They are also available upon request from the Research Grants Administrator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301. *Please use only the current 1997 application and appraisal forms.*

Confidential evaluations from two faculty members are required from candidates for the M.S. or Ph.D. degree and must accompany applications submitted. PLEASE USE THE "APPRAISAL OF APPLICANT" FORMS, WHICH ACCOMPANY THE 1997 APPLICATION FORMS. Application forms will not be accepted by facsimile.

The Geological Society of America awarded over $349,000 in grants in 1996. The grants went to 218 students doing research for advanced degrees. The average amount awarded was $1604. The largest grant was $2530, but there is no predetermined maximum amount. Funding for this program is provided by a number of sources, including GSA's Penrose and Pardee endowments, the National Science Foundation, industry, individual GSA members through the GEOSTAR and Research Grants funds, and numerous dedicated research funds that have been endowed at the GSA Foundation by members and families.

The Committee on Research Grants will meet in March to evaluate applications and award grants. In April, all applicants for grants will be informed of the committee's actions by the Executive Director of the Geological Society of America.

ALL APPLICATIONS MUST BE SUBMITTED ON THE 1997 FORMS AND POSTMARKED BY FEBRUARY 15, 1997

Coal Geology Division

The Coal Geology Division presented the annual Antoinette Lierman Medlin Scholarship Award to Bradley D. Ritts, Stanford University, for his proposal, "Tectonics and Sedimentation of Qaidam and South Tarim Basins, NW China: Implications for Mesozoic and Cenozoic Tectonic and Structural Evolution of the Northern Tibet Plateau." The Division presented the Medlin Field Research Award to Timothy S. White, Pennsylvania State University, University Park, for "A Sequence Stratigraphic Interpretation of Non-Marine Coal-Bearing and Marine Oil-Source Rocks: Implications for Fluctuations in Climate."

Engineering Geology Division

The student research grant awarded by the Engineering Geology Division for an outstanding research proposal was presented to Christine L. Luther of the University of Nevada, Reno, for her project "Thermal Rock and Rock Bolt Interaction Relating to Strength Behavior and Failure Mechanisms of Rock."

Geophysics Division

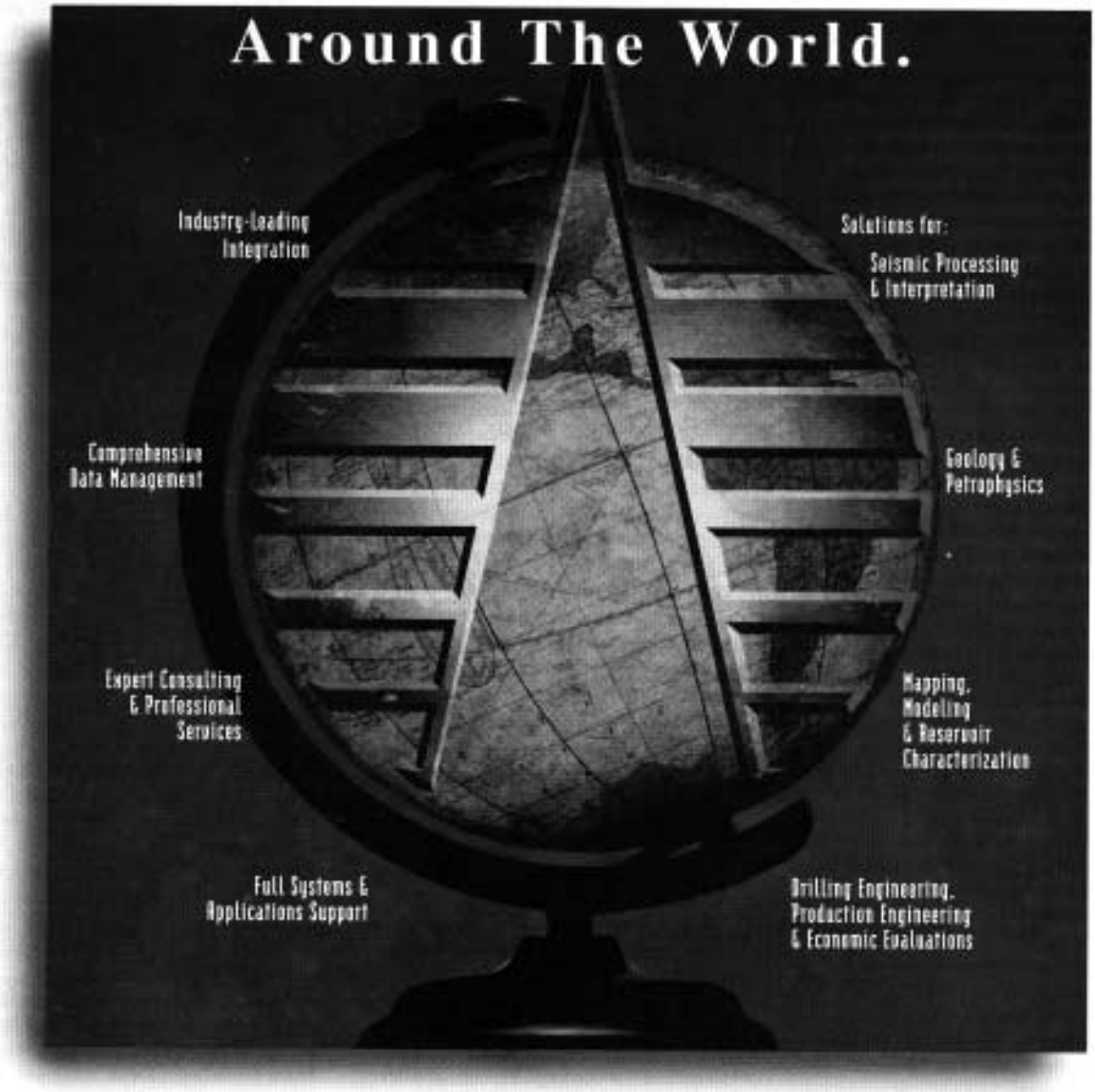
The Geophysics Division presented the Allan V. Cox Student Research Award this year for an outstanding student research proposal submitted to the GSA Research Grants Program to Haitao Yang, University of Western Ontario, for his project, "Viscosity of a Liquid in the Fe-Si-S System: Effects of Temperature and Pressure."

Hydrogeology Division

Awards for outstanding student research from the Hydrogeology Division were presented this year to three students: Rachel A. Ames, Iowa State University, for "Biodegradation of Atrazine in Subsurface Sediments from a Former Agricultural Chemical Dealership, Illinois"; Martin F. Helmke, Iowa State University, for "Determination of Hydraulic Conductivity and Effective Fracture Porosity in Till from Large-Diameter, Undisturbed Core Samples"; William W. Montgomery, Western Michigan University for "Ground-water Hydraulics and Slope Stability Analysis—

Grants *continued on p. 26*

Delivering Innovation & Integration



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Call for Nominations

GSA Penrose Medal, Day Medal, and Honorary Fellows

Penrose Medal. The Penrose Medal was established in 1927 by R. A. F. Penrose, Jr., to be awarded in recognition of eminent research in pure geology, for outstanding original contributions or achievements that mark a major advance in the science of geology. The award is made only at the discretion of the Council. Nominees are selected by the Council and may or may not be members of the Society. Penrose's sole objective in making the gift was to encourage original work in purely scientific geology. Scientific achievements should be considered rather than contributions in teaching, administration, or service. Mid-career scientists who have already made exceptional contributions should be given full consideration for the award.

Day Medal. The Day Medal was established in 1948 by Arthur L. Day to be awarded annually, or less frequently, at the discretion of the Council, for outstanding distinction in contributing to geologic knowledge through the application of physics and chemistry to the solution of geologic problems. Day's intent was to recognize outstanding achievement and inspire further effort, rather than reward a distinguished career. Scientific achievements should be considered rather than contributions in teaching, administration, and service.

Honorary Fellows. Geologists who have distinguished themselves in geological investigations or in notable service to the Society may be elected as Honorary Fellows. In practice, nearly all candidates are non–North Americans who live and work outside of North America. The most noteworthy exceptions were astronauts. Most Honorary Fellows have been elected after many years of outstanding and internationally recognized contributions to the science. The program was established by the GSA Council in 1909, and since then, except during a few war years, one or more Honorary Fellows have been elected annually. The Council of the Society encourages the membership to submit names of qualified candidates for this honor. In preparing a nomination, it is imperative that the original research and scientific advances of the candidate be stressed. All supporting data, especially degrees received, publications, positions, etc., should also be verified by the nominator.

How to Nominate

To ensure thorough consideration by the respective committees, please submit for each candidate a brief biographical sketch, such as used in *American Men and Women of Science* and *Who's Who in America,* a summary of the candidate's scientific contributions to geology that qualify the individual for the award, and a selected bibliography of no more than 20 titles.

A nomination for any one of these three awards *must be supported* by signed letters from each of five (5) GSA Fellows or Members in addition to the person making the nomination. The letters may be attached to the nomination form or may be sent to the Executive Director separately. For Honorary Fellow nominations, please verify degrees received, publications, positions held, etc. The names of unsuccessful candidates proposed to the Council by the respective committees will remain for consideration by those committees for three years. For those still under consideration, it is recommended that an updated letter of renomination be sent to the Executive Director.

The **deadline** for receipt of nominations at the office of the Executive Director is **February 3, 1997.** ■

About the Honorary Fellow Program

On page 27 you will find a form to be used in nominating candidates for Honorary Fellowship in the Geological Society of America. Each year this honor is bestowed on non–North Americans who live and work outside of North America and have distinguished themselves in geological investigations or in notable service to the Society. Under exceptional circumstances, North Americans have been named Honorary Fellows. This amendment to the bylaws was made in 1969 when the Apollo II astronauts who first walked on the moon were elected.

The program was established by the GSA Council in 1909, and since then, except during a few war years, one or more Honorary Fellows have been elected annually. Most Honorary Fellows have been elected after many years of outstanding and internationally recognized contributions to the science. At present there are 64 living geologists who have received this honor.

The Council of the Society encourages the membership to submit names of qualified candidates for this honor. In preparing a nomination, it is imperative that the original research and scientific advances of the candidate be stressed. All supporting data, especially degrees received, publications, positions, etc., should also be verified by the nominator. Use the form on page 27 for nominating a candidate for Honorary Fellowship. ■

Grants *continued from p. 24*

Elements for Prediction of Shoreline Recession."

Planetary Geology Division

The Planetary Geology Division presents the Stephen E. Dwornik Best Student Paper Awards annually to students who are pursuing advanced degrees in planetary sciences. The awards are presented each year for papers given in March at the Lunar and Planetary Science Conference. Recipients of the 1996 awards are Catherine Weitz, Brown University, best oral presentation, for "Eruption and Emplacement of Lunar Pyroclastics as Inferred from the 74001/2 Section," and Darren M. Williams, Pennsylvania State University, best poster presentation, for "Habitable Planets with High Obliquities." Recipients of the awards are presented with a citation and a $500 cash prize in an awards ceremony held at NASA Headquarters in Washington, D.C., early in the summer.

Quaternary Geology and Geomorphology Division

The Quaternary Geology and Geomorphology Division awarded the Arthur D. Howard Research Grant to David P. Bouchard, Utah State University, for "Quaternary Bear River—Bonneville Basin Paleohydrogeography Reconstructed from the $^{87}Sr/^{86}Sr$ Composition of Lacustrine Fossils," and the J. Hoover Mackin Grant to Brenda L. Hall, University of Maine, for "Geological Assessment of Abrupt Climate Change and Ice-sheet Stability Hypotheses from an Antarctic Perspective."

Sedimentary Geology Division

The Sedimentary Geology Division presented its 1996 award for an outstanding student research proposal to Laura Ann Banfield, Rice University, for "Comparative

Grants *continued on p. 35*

THE GEOLOGICAL SOCIETY OF AMERICA

Nomination for Penrose Medal, Day Medal, or Honorary Fellowship

(please circle one)

NAME OF CANDIDATE: _____

ADDRESS: _____

Telephone: _____

REQUIRED INFORMATION (Please attach)

BIOGRAPHICAL INFORMATION
Suggested sources: *American Men and Women of Science, Who's Who in America*
GSA Service Record (obtainable from headquarters)
Other

SUMMARY OF SCIENTIFIC CONTRIBUTIONS TO GEOLOGY
Not more than 200 words.

SELECTED BIBLIOGRAPHY
No more than 20 titles.

LETTERS OF SUPPORT
Nominations for any one of these three awards MUST BE SUPPORTED by signed letters from five (5) GSA Fellows or Members in addition to the person making the nomination. The letters may be attached to this nomination form or may be sent to the Executive Director separately. Supporting letters must discuss the original research and scientific advances of the candidates. Please also verify all other supporting data.

Name of person making the nomination: _____ Phone: _____

Address: _____

Date: _____ Signature: _____

Letters of support will be submitted by:

1. _____

2. _____

3. _____

4. _____

5. _____

RETURN TO: GSA Executive Director, P.O. Box 9140, Boulder, CO 80301, Phone: (303) 447-2020

DEADLINE: Completed nominations must be received by **February 3, 1997.** To be considered, nomination materials must meet the above criteria. Reprints or articles will not be accepted.

Call for Nominations

Young Scientist Award (Donath Medal)

The Young Scientist Award was established in 1988 to be awarded to a young scientist (35 or younger during the year in which the award is to be presented) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award, consisting of a gold medal called the Donath Medal, and a cash prize of $15,000 was endowed by Dr. and Mrs. Fred A. Donath.

For the year 1997, only those candidates born on or after January 1, 1962, are eligible for consideration. In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1997 award must include:

- biographical information,
- a summary of the candidate's scientific contributions to geology (200 words or less),
- a selected bibliography (no more than 10 titles),
- supporting letters from five scientists in addition to the person making the nomination.

Nominations for the 1997 Young Scientist Award must be received at GSA headquarters by *February 3, 1997.* ■

GSA Medalists and Honorary Fellows

Richard A. F. Penrose, Jr., Medalists

1927 Thomas Chrowder Chamberlin
1928 Jakob Johannes Sederholm
1929 *No award given*
1930 Francois Alfred Antoine Lacroix
1931 William Morris Davis
1932 Edward Oscar Ulrich
1933 Waldemar Lindgren
1934 Charles Schuchert
1935 Reginald Aldworth Daly
1936 Arthur Philemon Coleman
1937 *No award given*
1938 Andrew Cowper Lawson
1939 William Berryman Scott
1940 Nelson Horatio Darton
1941 Norman Levi Bowen
1942 Charles Kenneth Leith
1943 *No award given*
1944 Bailey Willis
1945 Felix Andries Vening-Meinesz
1946 T. Wayland Vaughan
1947 Arthur Louis Day
1948 Hans Cloos
1949 Wendell P. Woodring
1950 Morley Evans Wilson
1951 Pentti Eskola
1952 George Gaylord Simpson
1953 Esper S. Larsen, Jr.
1954 Arthur Francis Buddington
1955 Maurice Gignoux
1956 Arthur Holmes
1957 Bruno Sander
1958 James Gilluly
1959 Adolf Knopf
1960 Walter Herman Bucher
1961 Philip Henry Kuenen
1962 Alfred Sherwood Romer
1963 William Walden Rubey
1964 Donnel Foster Hewett
1965 Philip Burke King
1966 Harry H. Hess
1967 Herbert Harold Read
1968 J. Tuzo Wilson
1969 Francis Birch
1970 Ralph Alger Bagnold
1971 Marshall Kay
1972 Wilmot H. Bradley
1973 M. King Hubbert
1974 William Maurice Ewing
1975 Francis J. Pettijohn
1976 Preston Cloud
1977 Robert P. Sharp
1978 Robert M. Garrels
1979 J Harlen Bretz
1980 Hollis D. Hedberg
1981 John Rodgers
1982 Aaron C. Waters
1983 G. Arthur Cooper
1984 Donald E. White
1985 Rudolf Trümpy
1986 Laurence L. Sloss
1987 Marland P. Billings
1988 Robert S. Dietz
1989 Warren Bell Hamilton
1990 Norman D. Newell
1991 William R. Dickinson
1992 John Frederick Dewey
1993 Alfred G. Fischer
1994 Luna B. Leopold
1995 John C. Crowell
1996 John Robert Lawrence Allen

Arthur L. Day Medalists

1948 George W. Morey
1949 William Maurice Ewing
1950 Francis Birch
1951 Martin J. Buerger
1952 Sterling Hendricks
1953 John F. Schairer
1954 Marion King Hubbert
1955 Earl Ingerson
1956 Alfred O. C. Nier
1957 Hugo Benioff
1958 John Verhoogen
1959 Sir Edward C. Bullard
1960 Konrad B. Krauskopf
1961 Willard F. Libby
1962 Hatten Schuyler Yoder
1963 Keith Edward Bullen
1964 James Burleigh Thompson, Jr.
1965 Walter H. Munk
1966 Robert M. Garrels
1967 O. Frank Tuttle
1968 Frederick J. Vine
1969 Harold C. Urey
1970 Gerald J. Wasserburg
1971 Hans P. Eugster
1972 Frank Press
1973 David T. Griggs
1974 A. E. Ringwood
1975 Allan Cox
1976 Hans Ramberg
1977 Akiho Miyashiro
1978 Samuel Epstein
1979 Walter M. Elsasser
1980 Henry G. Thode
1981 Donald L. Turcotte
1982 Eugene M. Shoemaker
1983 Harmon Craig
1984 Wallace S. Broecker
1985 Freeman Gilbert
1986 E-an Zen
1987 Don L. Anderson
1988 Claude J. Allègre
1989 Dan McKenzie
1990 William S. Fyfe
1991 Ian Carmichael
1992 Susan Werner Kieffer
1993 Hugh P. Taylor, Jr.
1994 David Walker
1995 Thomas J. Ahrens
1996 Robert A. Berner

Young Scientist Award (Donath Medalists)

1989 Mark Cloos
1990 Leigh Handy Royden
1991 Brian Philip Wernicke
1992 John Peter Grotzinger
1993 Michael Gurnis
1994 An Yin
1995 Ward Earl Sanford
1996 Paul R. Bierman

Honorary Fellows

Edwin "Buzz" Aldrin
Neil Armstrong
Jean A. Aubouin
Krzysztof Ludwik Birkenmajer
Alfonso Bosellini
George Malcolm Brown
S. Warren Carey
Maria Bianca Cita
Michael Collins
William Compston
Douglas Saxon Coombs
P. G. Cooray
Bruno d'Argenio
Gabriel Dengo
Kingsley C. Dunham
Stanislaw Dzulynski
François Ellenberger
Hans Füchtbauer
William S. Fyfe
Augusto Gansser
David Headley Green
Francisco Hervé
Dorothy Hill
Ferenc Horvath
Kenneth J. Hsü
Valdar Jaanusson
Emilie Jäger
Ihsan Ketin
Teiichi Kobayashi
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Leo Y. Picard
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Jean Piveteau
Isabella Premoli-Silva
Desmond A. Pretorius
B. P. Radhakrishna
Hans Ramberg
Victor A. Ramos
John G. Ramsay
Alfred Rittmann
Alexander B. Ronov
Rupert W. R. Rutland
Kristján Sæmundsson
Rushdi Said
Hitoshi Sakai
Mircea Sandulescu
Harrison Hagan Schmitt
Eugen Seibold
Ali Mehmet Celal Şengör
Boris Sergeevich Sokolov
Richard L. Stanton
Rashid A. Khan Tahirkheli
Paul Tapponnier
Bernard P. Tissot
Livio Trevisan
Rudolf Trümpy
Guangzhi Tu
Harry B. Whittington
Alwyn Williams
Yang Zun-yi

THE GEOLOGICAL SOCIETY OF AMERICA

Nomination for 1997 Young Scientist Award (Donath Medal)

NAME OF CANDIDATE:_____ Date of birth:_____

For the year 1997, only those candidates born on or after January 1, 1962, are eligible for consideration.

ADDRESS: _____

REQUIRED INFORMATION (Please attach)

BIOGRAPHICAL INFORMATION
Provide in a format similar to that found in *American Men and Women of Science, Who's Who in America.*

SUMMARY OF SCIENTIFIC CONTRIBUTIONS TO GEOLOGY
Not more than 200 words.

SELECTED BIBLIOGRAPHY
No more than 10 titles.

LETTERS OF SUPPORT
Nominations for the Donath Medal MUST BE SUPPORTED by signed letters from five (5) scientists in addition to the person making the nomination. The letters may be attached to this nomination form or may be sent to the Executive Director separately.

Name of person making the nomination: _____

Address: _____

Date: _____ Signature: _____

Letters of support will be submitted by:

1. _____

2. _____

3. _____

4. _____

5. _____

RETURN TO: GSA Executive Director
P.O. Box 9140
Boulder, CO 80301
Phone: (303) 447-2020

DEADLINE: Completed nominations must be received by **February 3, 1997.** To be considered, nomination materials must meet the above criteria. Reprints or articles will not be accepted.

Call for Nominations for 1997 GSA Distinguished Service Award

The GSA Distinguished Service Award was established by Council in 1988 to recognize individuals for their exceptional service to the Society. GSA Members, Fellows, Associates, or, in exceptional circumstances, GSA employees may be nominated for consideration. Any GSA member or employee may make a nomination for the award. Awardees will be selected by the Executive Committee, and all selections must be ratified by the Council. Awards may be made annually, or less frequently, at the discretion of Council. This award will be presented during the Annual Meeting of the Society. Letters of nomination and any supporting information should be addressed to Executive Director, GSA, P.O. Box 9140, Boulder, CO 80301.

Deadline for nominations for 1997 is March 3, 1997.

Recipients to date:

1988	*Campbell Craddock*
	Robert D. Hatcher, Jr.
	Eldridge M. Moores
	William A. Thomas
1990	*William B. Heroy, Jr.*
1991	*Dorothy M. Palmer*
1992	*A. R. (Pete) Palmer*
1993	*Michel T. Halbouty*
1994	*F. Michael Wahl*
1995	*John E. Costa*
	Henry T. Mullins
	Arthur G. Sylvester
1996	*David M. Fountain*
	Royann (Gardner) Cygan
	Louis C. Pakiser, Jr.
	Anthony Reso

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Call For Nominations

1999 National Awards *(Deadline: April 30, 1997)*

Nominations for the national awards described below are being solicited for 1999. Each year GSA members have been invited to participate by recommending possible candidates.

Those who wish to make nominations are urged to do so by sending background information and vitae, and specifying the award for which the candidate is being submitted by April 30, 1997, to the GSA External Awards Committee, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, fax 303-447-1133. The nomination process is coordinated by AGI on behalf of its member societies, and a roster of candidates will be finalized by the AGI Member Society Council at its spring 1998 meeting for nomination to the respective offices sponsoring the national awards.

William T. Pecora Award

The Pecora Award, sponsored jointly by NASA and the Department of the Interior, is presented annually in recognition of outstanding contributions of individuals or groups toward the understanding of Earth by means of remote sensing.

The award recognizes contributions of those in the scientific and technical community as well as those involved in the practical application of remote sensing. Consideration will be given to sustained or single contributions of major importance to the art or science of the understanding of Earth through observations made from space.

National Medal of Science

The medal is awarded by the President to individuals "deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, engineering, or social and behavioral sciences."

There are now many younger American scientists and engineers who may be reaching a point where their contributions are worthy of recognition. The committee is giving increasing attention to these individuals as well as to those outstanding women and minority scientists who deserve recognition.

Vannevar Bush Award

The Vannevar Bush Award is presented from time to time to a person who, through public service activities in science and technology, has made an outstanding contribution toward the welfare of mankind and the nation.

The award is given to a senior statesman of science and technology and complements the NSF's Alan T. Waterman Award, which is given to a promising young scientist. The two awards are designed to encourage individuals to seek the highest levels of achievement in science, engineering, and service to humanity.

The nomination should be accompanied by a complete biography and a brief citation summarizing the nominee's scientific or technological contributions to our national welfare in promotion of the progress of science.

Alan T. Waterman Award

The Waterman Award is presented annually by the NSF and National Science Board to an outstanding young researcher in any field of science or engineering supported by NSF.

Candidates must be U.S. citizens or permanent residents and must be 35 years of age or younger, OR not more than five years beyond receipt of the Ph.D. degree by December 31 of the year in which nominated.

Candidates should have completed sufficient scientific or engineering research to have demonstrated, through personal accomplishments, outstanding capability and exceptional promise for significant future achievement.

Remember: Background information and vitae of nominated candidates should be sent by April 30, 1997, to the GSA External Awards Committee, P.O. Box 9140, Boulder, CO 80301. ■

Help Direct GSA's Future

The GSA Committee on Nominations requests your help in compiling a list of GSA members qualified for service as officers and councilors of the Society. The committee requests that each nomination be accompanied by basic data and a description of the qualifications of the individual for the position recommended (vice president, treasurer, councilor).

Nominations for 1998 officers and councilors must be received at GSA headquarters no later than **FEBRUARY 18, 1997.**

Please send nominations and back-up material to Administrative Department, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

b
Blackwell Science
ACN 004 901 562

The Island Arc

ISSN 1038-4871

Editors-in-Chief A. Taira and M. Komatsu **Executive Editor** K. Kodama

Editorial Scope

The aim of *The Island Arc* is to provide an opportunity for the prompt, international and high-standard publication of growing earth science research activities in the western Pacific rim and Asia, as well as other parts of the world. *The Island Arc* focuses on the structure, dynamics and evolution of plate convergence zones in modern and ancient settings. *The Island Arc* also deals with topics which may not be specific to plate convergence zones but are fundamental to understanding them. *The Island Arc* aims to be a major forum for the presentation and discussion of these important earth science objectives with high academic standards and broad international recognition.

Abstracting and Indexing

This journal is covered by *AESIS, Cambridge Scientific Abstracts, Geoarchive, Geobase, Geological Abstracts* and *Petroleum Abstracts, University Microfilms.*

The Island Arc is published quarterly in March, June, September and December.

The subscription rates for 1996 (Volume 5) are Institutional: ¥29,000 (Japan) and A$423.00 (Australasia), US$300.00 and Individual: A$204 (Australasia), US$145.

Prices include postage and delivery is by surface-air lifted post.

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Preliminary Announcement and Call for Papers

SOUTHEASTERN SECTION, GSA 46th Annual Meeting

Auburn, Alabama
March 27–28, 1997

The 1997 meeting of the Southeastern Section of the Geological Society of America in Auburn, Alabama, will be hosted by the Auburn University Department of Geology.

SETTING

Auburn is situated along the boundary between the Piedmont and Gulf Coastal Plain provinces, a one-hour drive east of the Valley and Ridge. Auburn lies 50 miles east of Montgomery, the state capital, 110 miles southeast of Birmingham, and 110 miles west of Atlanta, Georgia, and is near Horseshoe Bend National Military Park, FDR's Warm Springs Little White House, and Callaway Gardens. The GSA Southeastern Section meeting will be held at the Auburn University Hotel and Conference Center. Auburn is easily reached by car via Interstate 85 and by shuttle service from Atlanta's Hartsfield International Airport.

CALL FOR PAPERS

Papers are invited for presentation in oral technical sessions, symposia, theme sessions, and poster sessions. Although papers dealing with all aspects of the southeastern or Appalachian regions of the United States are especially encouraged, papers dealing with other regions are also welcome. Abstracts not accepted for symposia (invited) or theme (volunteered) sessions will be considered for regular technical sessions.

REGISTRATION

Preregistration Deadline: February 21, 1997

Please preregister to qualify for lower registration fees and to assist the local committee in planning. On-site registration, at a higher fee, will also be available. A reduced registration fee during the preregistration period will be offered to students and to precollege teachers. Field trip participants must register for the meeting.

Preregistration by mail will be handled by the GSA Registration Coordinator, P.O. Box 9140, Boulder, CO 80301-9140. Registration forms will appear in the January 1997 issue of *GSA Today.*

ABSTRACTS

Abstract Deadline: December 2, 1996

Abstracts for all sessions must be submitted camera-ready on official 1997 GSA abstract forms. These forms are available from the Abstracts Coordinator, Geological Society of America, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, ext. 161, E-mail: ncarlson@geosociety.org.

An original and five copies of all abstracts (volunteered and invited) should be sent to Charles E. Savrda, Dept. of Geology, Auburn University, Auburn, AL 36849. We encourage participants in symposia and theme sessions to send an extra copy to the convener of the session. Abstracts will be reviewed for information content, format, and originality. GSA rules prohibit individuals from presenting more than one volunteered abstract. Abstracts submitted for symposia are not affected by this limitation.

FIELD TRIPS

Auburn's central location to the Piedmont, Valley and Ridge, and Gulf Coastal Plain provinces makes it an excellent base for many interesting field trips. Contact the field trip leaders listed below for details about particular field trips. For general questions concerning field trips, or if you are interested in proposing an additional field trip, please contact James A. Saunders, field trip coordinator, (334) 844-4884, saundja@mail.auburn.edu. The postal address for all Auburn Univeristy field trip leaders is: Dept. of Geology, Auburn Univeristy, Auburn, AL 36849-5305.

Field Trips—Tentative

1. **Salt Mountain Limestone: A Paleocene Coral-Algal-Sponge Reef, Southwestern Alabama.** Jonathan R. Bryan, Earth Sciences, Okaloosa-Walton Community College, 100 College Blvd., Niceville, FL 32578, (904) 729-5246, jbryanowcc@aol.com.
2. **Sedimentology of Carboniferous Foreland Basin Deposits in Alabama.** *Sponsored by SEPM.* Jack Pashin, Alabama Geological Survey, P.O. Box O, Tuscaloosa, AL 35486-4780, (205) 349-2852; and Robert A. Gastaldo, Auburn University, (334) 844-4885, gastara@mail.auburn.edu.
3. **Industrial Minerals and Rocks of the Southeast.** Robert S. Fousek, McCartney Construction Co., Inc., P.O. Box 1890, Gadsden, AL 35902-1890, (205) 547-6386, fax (205) 547-6390; and Robert B. Cook, Auburn University, (334) 844-4891, cookrob@mail.auburn.edu.
4. **The Wetumpka Astrobleme.** Tony Neathery, 1212-H 15th St. E., Tuscaloosa, AL 23505, (205) 553-5466; and David T. King, Jr., Auburn University, (334) 844-4882, kingdat@mail.auburn.edu.
5. **Comparison of the Pine Mountain Belt Cover Sequence with Basal Paleozoic Rocks in the Talladega Slate Belt, Alabama.** Denny Bearce, Dept. of Geology, University of Alabama at Birmingham, Birmingham, AL 35294, (205) 934-2439, geof005@uabdpo.dpo.uab.edu; James Tull, Dept. of Geology, Florida State University, Tallahassee, FL 32306, (904) 644-4214, tull@geomag.gly.fsu.edu; and Mark Steltenpohl, Auburn University, (334) 844-4893, steltmg@mail.auburn.edu.
6. **Mylonites of the Pine Mountain Window, Alabama.** Thomas Hanley, Dept. of Chemistry & Geology, Columbus College, Columbus, GA 31907-5645, (706) 568-2075, hanley_tom@mercury.csg.peachnet.edu; and Mark Steltenpohl, Auburn University, (334) 844-4893, steltmg@mail.auburn.edu.
7. **Self-guided Tour of the Geology of Chewacla State Park: Grenville Basement and Pine Mountain Group Cover Sequence, Pine Mountain Window, Alabama.** Brandon Coates, Auburn University Geology Club, Auburn University, Auburn, AL 36849-5305, (334) 844-4282, coatebh@mail.auburn.edu.
8. **Teachers' Field Trip to Selected Exposures in the Piedmont and Coastal Plain Provinces near Auburn, Alabama.** Jack Carrington, Auburn University, (334) 844-4282, carrith@mail.auburn.edu.

SYMPOSIA

In addition to the general discipline sessions, 16 symposia are already planned for the meeting. Anyone interested in these should contact the conveners for information. Individuals with suggestions for additional symposia are encouraged to contact Charles E. Savrda, Dept. of Geology, Auburn University, Auburn, AL 36849-5305, (334) 844-4887, savrdce@mail.auburn.edu. The postal address for all Auburn University conveners is: Dept. of Geology, Auburn Univeristy, Auburn AL 36849-5305.

1. **Phanerozoic Organic Buildups of the Southeastern United States** (SE Paleontological Society). Frank K. (Ken) McKinney, Dept. of Geology, Appalachian State University, Boone, NC 28608, (704) 262-2748, mckinneyfk@appstate.edu; and Carl W. Stock, Dept. of Geology, University of Alabama, Box 870338, Tuscaloosa, AL 35487-0338, (205) 348-1883, cstock@wgs.geo.ua.edu.

Southeastern *continued on p. 33*

Southeastern *continued from p. 32*

2. **Groundwater Geochemistry, Microbiology, and Bioremediation.** Sponsored by the GSA Institute for Environmental Education. James A. Saunders, Auburn University, (334) 844-4884, saundja@mail.auburn.edu; and W. Berry Lyons, Dept. of Geology, University of Alabama, Tuscaloosa, AL 35487, (205) 348-0583, Blyons@wgs.geo.ua.edu.
3. **Modern Analogs in Paleontology.** Ronald D. Lewis, Auburn University, (334) 844-4886, lewisrd@mail.auburn.edu; and Sally Walker, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2652, swalker@uga.cc.uga.edu.
4. **Industrial Minerals and Rocks of the Southeast.** Robert B. Cook, Auburn University, (334) 844-4891, cookrob@mail.auburn.edu; and Robert S. Fousek, McCartney Construction Co., Inc., P.O. Box 1890, Gadsden, AL 35902-1890, (205) 547-6386, fax 205-547-6390.
5. **Current Directions in Archaeological Geology of Late and Post-Pleistocene Environments.** Erv Garrison, Dept. of Anthropology, Baldwin Hall, University of Georgia, Athens, GA 30602-1619, (706) 542-3922, egarriso@sherlock.dac.uga.edu.
6. **Geophysical Studies of the Shallow Subsurface.** Lorraine Wolf, Auburn University, (334) 844-4878, lwolf@geology.auburn.edu.
7. **Biomineralization.** Roger M. Leblanc, Dept. of Chemistry, University of Miami, 1301 Memorial Drive, Room 315, P.O. Box 249118, Coral Gables, FL 33124-0431, (305) 284-2282, mmodrono@miami.ir.miami.edu.
8. **Solid Earth Science: The Foundation of Ecosystem Management and Defendable Environmental Regulations.** Walt Schmidt, Florida Geological Survey, 903 W. Tennessee St., Tallahassee, FL 32304-7700, (904) 488-4191, schmidt_w@dep.state.fl.us.
9. **Coastal Sedimentology.** W. F. Tanner, Dept. of Geology, Florida State University, Tallahassee, FL 32306-3026, (904) 644-3208.
10. **Quantitative Studies of the Pressures, Temperatures and Durations of Metamorphic Processes.** Bill Hames, Auburn University, (334) 844-4881, hameswe@mail.auburn.edu; and Harold Stowell, Dept. of Geology, University of Alabama, 202 Bevill Building, Tuscaloosa, AL 35487-0338, (205) 348-5095, hstowell@wgs.geo.ua.edu.
11. **Mechanisms of Folding and Fracturing in Appalachian Foreland-style Structures.** Jon Mies, Dept. of Physics, Geology & Astronomy, University of Tennessee at Chattanooga, Chattanooga, TN 37403, (615) 755- 4404, jmies@utcvm.utc.edu; and Rick Groshong, Dept. of Geology, University of Alabama, Bevill Building, Tuscaloosa, AL 35487-0338, (205) 348-5095, rgroshon@wgs.geo.ua.edu.
12. **Precambrian Evolution of the Southern Appalachians.** Steven Goldberg, Dept. of Geology, University of North Carolina, Chapel Hill, NC 27599-3315, (919) 962-0692, steven_goldberg@unc.edu.
13. **Tectonics and Isotopes in the Appalachians.** Jim Hibbard, Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27695-8208, (919) 515-7242, jhibbard@ncsu.edu; and Scott Samson, Dept. of Earth Sciences, Syracuse University, Syracuse, NY 13244-1070, (315) 443-2672, sdsamson@summon.syr.edu.
14. **Characteristics of Paleogene Epoch Boundaries in the Eastern Gulf Coastal Plain: Biotic and Physical Events.** Barry Tew, Geological Survey of Alabama, P.O. Box O, Tuscaloosa, AL 35486-9780, (205) 349-2852, nick@sand.gsa.tuscaloosa.al.us; and Ernie Mancini, Dept. of Geology, University of Alabama, Bevill Building, Tuscaloosa, AL 35487-0338, (205) 348-5095, emancini@wgs.geo.ua.edu.

Southeastern *continued on p. 34*

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MONTHLY
RESEARCH

GSA Bulletin
An authoritative science journal covering active research areas in the earth sciences. Publishes 8–12 refereed research articles each month. The Bulletin's 100+ year record of regularly publishing important research developments reflects the evolution of the modern geological sciences. Articles span terrestrial to marine and modern to ancient environments, integrating chemical, physical, and biological information to unravel Earth's processes, history, and future. The Discussion and Reply section provides for lively debate on current topics. About 1700 pages annually. Illustrations are profuse and include full-color covers and occasional large-format inserts.

MONTHLY
TOPICAL & CONCISE

Geology
Undoubtedly the most popular and widely read general geological journal in print, each month bringing you 20 or more refereed articles that are concise (4-page maximum), current, and thought provoking, covering a wide range of geological subjects, including new investigations. The Geology Forum provides an arena for stimulating reader comments and responses on the articles. About 1150 pages annually. Profusely illustrated, includes color and occasional large inserts. The full-color covers are exceptional geological studies in themselves.

QUARTERLY
APPLIED SCIENCES

Hydrogeology Journal* Quarterly journal of the International Association of Hydrogeologists (IAH), available to GSA members at the IAH-member price. Features peer-reviewed papers in theoretical and applied hydrogeology. Published in English, with abstracts also in French and Spanish. Describes worldwide progress in the science and provides an affordable and widely accessible forum for scientists, researchers, engineers, and practitioners. Papers integrate subsurface hydrology and geology with supporting disciplines.

Environmental & Engineering Geoscience* A joint, quarterly publication of the Association of Engineering Geologists (AEG) and the Geological Society of America (GSA). Includes refereed articles on applied topics in the environmental and hydrological geosciences, and special features like the Geology of Cities series; technical notes on current topics; a comment and reply forum; memorials to geologists of note; book reviews; and biographies on well-known geologists in the applied fields. It will feature new theory, applications, and case histories illustrating the dynamics of the fast-growing, environmental and applied disciplines. Co-edited by AEG and GSA.

*Members of IAH receive Hydrogeology Journal as part of their IAH dues and should not order from GSA. Members of AEG receive Environmental & Engineering Geoscience as part of their AEG dues and should not order from GSA.

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Each edition includes full content of GSA Bulletin, Geology and GSA Today; plus a Retrospective Index from 1972 forward. Does not include AEG or IAH journals.

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See the PUBLICATIONS section, for tables of contents and abstracts of each article in GSA Bulletin and Geology: http://www.geosociety.org

GSA TODAY GSA's monthly news magazine. Features late-breaking, hot-topic science articles, a forum for discussion of current topics, legislative updates, news about the Society and the earth-science community, job opportunities, meeting announcements, and more!

ABSTRACTS WITH PROGRAMS Published in conjunction with GSA's regular scientific meetings. Contains abstracts of all papers to be presented at the related meeting plus programs for that meeting. Essential guides for meeting attendees; a valuable summary of current science.

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Southeastern *continued from p. 33*

15. **Animal-Substrate Relations in Modern and Ancient Environments.** Anthony J. Martin, Geosciences Program, Emory University, Atlanta, GA 30322, (404) 727-6476, paleoman@learnlink.emory.edu.
16. **Recent Advances in Southeastern Vertebrate Paleontology.** David Schwimmer, Dept. of Chemistry & Geology, Columbus College, Columbus, GA 31907-5645, schwimmer_david@colstate.edu.

THEME SESSIONS

Several theme sessions (all papers volunteered) are planned, as indicated below. Individuals interested in convening an additional theme session should contact Charles E. Savrda, Dept. of Geology, Auburn University, Auburn, AL 36849, (334) 844-4887, savrdce@mail.auburn.edu.
1. **Advances in Southeastern Cretaceous Geology.** David T. King, Jr., Dept. of Geology, Auburn University, Auburn, AL 36849-5305, (334) 844-4882, kingdat@mail.auburn.edu.
2. **Rock and Fluid Chemistry of Brittle Fault Zones.** Jaffar Hadizadeh, 325 Natural Science Building, University of Louisville, Louisville, KY 40292, (502) 852-6821, j0hadi01@ulkyvm.louisville.edu.
3. **Piedmont Subsurface Hydrology.** John Dowd and David Wenner, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542-2382/2393, dwenner@uga.cc.uga.edu.
4. **Field Mapping in the Southern Appalachians:** *A Poster Session in Memory of J. Robert Butler.* Steven Goldberg, Dept. of Geology, University of North Carolina, Chapel Hill, NC 27599-3315, (919) 962-0692, steven_goldberg@unc.edu; and Jon Mies, Dept. of Physics, Geology & Astronomy, University of Tennessee at Chattanooga, Chattanooga, TN 37403, (615) 755-4404, jmies@utcvm.utc.edu.
5. **New Developments in the Geology of the Piedmont.** Alberto Patino-Douce, Dept. of Geology, University of Georgia, Athens, GA 30602, (706) 542- 2652.
6. **Coastal Response to Environmental Change.** Ron Hoenstine, Florida Geological Survey, Gunter Building, 902 W. Tennessee St., Tallahassee, FL 32304-7700, (904) 488-9380, hoenstine_r@dep.state.fl.us; and Joseph Donoghue, Dept. of Geology, Florida State University, Tallahassee, FL 32306, (904) 644-4214, jdonoghu@garnet.acns.fsu.edu.
7. **Student Research Activities** (Sigma Gamma Epsilon). Don Neal, Dept. of Geology, East Carolina University, Greenville, NC 27858-4353, (919) 328-6360, glneal@ecuvm.cis.ecu.edu; and Douglas Haywick, Dept. of Geology & Geography, University of South Alabama, LSCB 136, Mobile, AL 36688, (334) 460-6381, dhaywick@jaguar1.usouthal.edu.
8. **Undergraduate Research Poster Session** (Council on Undergraduate Research). Jack Beuthin, University of Pittsburgh, Johnstown, PA 15904, (814) 269-2945; and Bill Ranson, Dept. of Geology, Furman University, Greenville, SC 29613, (803) 294-2052, ranson_bill@furman.edu.
9. **K–12 and Introductory Earth Science Education.** Tom Hanley, Dept. of Chemistry & Geology, Columbus College, Columbus, GA 31907-5645, (706) 568-2075, hanley_tom@mercury.csg.peachnet.edu; and Jack Carrington, Dept. of Geology, Auburn University, Auburn, AL 36849-5305, (334) 844-4882, carrith@mail.auburn.edu.
10. **Remote Sensing in Geology.** Phil Manker, Dept. of Geology and Physics, Georgia Southwestern State University, Americus, GA 31709, (912) 931-2330, pmanker@canes.gsw.peachnet.edu.
11. **GIS Applications in Geology.** Greg Easson, University of Mississippi, Geology and Geological Engineering, 1180 Carrier Hall, University, MS 38677, (601) 232-5995, geasson@sunset.backbone.olemiss.edu

POSTER SESSIONS

Four half-day poster sessions are planned; we encourage poster contributions because they permit extended discussions. Please indicate your preference for a poster session on the GSA abstract form.

STUDENT RESEARCH PROGRAMS

Sigma Gamma Epsilon will sponsor an oral theme session (theme session 7, above) devoted to student research. The session is designed to showcase student scholarship without restriction on subject matter, classification, or membership in Sigma Gamma Epsilon. Interested students should contact either Don Neal, Dept. of Geology, East Carolina University, Greenville, NC 27858-4353, (919) 328-6360, glneal@ecuvm.cis.ecu.edu, or Douglas Haywick, Dept. of Geology & Geography, University of South Alabama, LSCB 136, Mobile, AL 36688, (334) 460-6381, dhaywick@jaguar1.usouthal.edu.

The Council for Undergraduate Research will sponsor a student poster session (theme session 8, above), to showcase senior theses and other undergraduate research projects. First authors must be undergraduate students and responsible for the bulk of the research, preparation of posters, and presentation of the results. For more information, contact either Jack Beuthin, University of Pittsburgh, Johnstown, PA 15904, (814) 269-2945, or Bill Ranson, Dept. of Geology, Furman University, Greenville, SC 29613, (803) 294-2052, ranson_bill@furman.edu.

NAGT WORKSHOP

The National Association of Geoscience Teachers and the National Science Education Division of Undergraduate Education will sponsor a Workshop on Innovative and Effective Teaching. This workshop, planned for Saturday, March 29, is intended for faculty and graduate students who are interested in learning more about effective and innovative teaching strategies. For more information, please contact R. Heather MacDonald, Dept. of Geology, College of William and Mary, Williamsburg, VA 23187, (757) 221-2443, rhmacd@acstaff.wm.edu.

OTHER EARTH SCIENCE EDUCATION PROGRAMS

Two half-day theme sessions (theme session 9, above) and a one-day field trip (field trip 8, above) are planned for K–12 and college-level introductory geology teachers. Those interested should contact either Jack Carrington, Dept. of Geology, Auburn University, Auburn, AL 36849-5305, (334) 844-4882, carrith@mail.auburn.edu, or Tom Hanley, Dept. of Chemistry & Geology, Columbus College, Columbus, GA 31907-5645, (706) 568-2075, hanley_tom@mercury.csg.peachnet.edu.

ROY SHLEMON MENTORS IN APPLIED GEOLOGY PROGRAM: WORKSHOP FOR STUDENTS

The Roy Shlemon Mentors in Applied Geology Program, sponsored by the GSA Institute for Environmental Education, is a new program developed to present workshops for upper-level undergraduate and graduate students. A workshop on applied ground-water microbiology and applications to bioremediation is planned for Saturday morning and a field excursion that afternoon, weather permitting. A Friday symposium on Groundwater Geochemistry, Microbiology, and Bioremediation (symposium 2) precedes the workshop. There is no charge to students for this short course, but space is limited. Interested students should contact James A. Saunders, Dept. of Geology, Auburn University, Auburn, AL 36849-5303, (334) 844-4884, saundja@mail.auburn.edu.

PROJECTION AND POSTER FACILITIES

Please bring your own loaded carousel trays, if possible. Two 35-mm slide projectors and screens will be available for each oral technical session. Overhead projectors will be available only by prior arrangement.

Posters will consist of one horizontally hung 4' × 8' foam board. Poster sessions will be set up for four hours, and

Southeastern *continued on p. 35*

Southeastern *continued from p. 34*

authors will be available for two hours to discuss their work.

EXHIBITS

Exhibit facilities for business, educational, and governmental institutions will be located conveniently in the Auburn University Hotel and Conference Center, adjacent to the technical sessions. The number of booths is limited, so plan to reserve space early. Exhibits will be open all day Thursday and on Friday morning. For further information and space reservations, contact Ron Lewis, Auburn University, (334) 844-4886, lewisrd@mail.auburn.edu.

STUDENT TRAVEL GRANTS

Limited funds for support of travel expenses for students presenting papers at the meeting are available from the GSA Southeastern Section. Students must be members of GSA to apply. For information, contact Harold Stowell, Dept. of Geology, University of Alabama, Tuscaloosa, AL 35486, (205) 348-5098, hstowell@wgs.geo.ua.edu. Travel grant requests must be postmarked no later than *March 3, 1997*.

ACCOMMODATIONS

A block of rooms at the Auburn Hotel and Conference Center, the site of the meeting, has been reserved for attendees, at a special reduced rate of $72 per night for either single or double occupancy.

WELCOME PARTY AND GUEST ACTIVITIES

The welcome party Wednesday evening will be in the atrium of the Auburn Alumni Center. All party attendees must be registered; on-site registration will be available in the Hotel and Conference Center lobby prior to the party.

Guests may wish to attend trips planned to beautiful Callaway Gardens on Thursday and/or historic Horseshoe Bend National Military Park on Friday. Scenic Chewacla State Park is only a 4-mile drive from the Hotel and Conference Center.

OTHER INFORMATION

The GSA Southeastern Section maintains a World Wide Web site that can be accessed at http://www.geo.ua.edu/segsa/segsa.html. This home page contains information about the management board, meetings, and student support for travel and research.

More detailed information concerning fees and registration, hotel accommodations, field trips, and other activities will appear in the January 1997 issue of *GSA Today* and as part of the GSA Southeastern Section *Abstracts with Programs* for 1997. Direct questions and suggestions to the local committee co-chairmen, Mark Steltenpohl (steltmg@mail.auburn.edu) and Robert A. Gastaldo (gastara@mail.auburn.edu), Dept. of Geology, Auburn University, Auburn, AL 36849-5305, (334) 844-4282. ■

Grants *continued from p. 26*

Analysis of the Relationship Between Continental Shelf, Slope, and Basin Floor Depositional Environments of the Deltaic Rio Grande System and the Neighboring Interfluve in the Western Gulf of Mexico, Utilizing Sedimentology and High Resolution Sequence Stratigraphy."

Structural Geology and Tectonics Division

The Structural Geology and Tectonics Division presented its 11th annual awards for outstanding student research this year to Mark A. Hemphill-Haley, University of Oregon, for "Investigation of Geometry, Mode of Displacement, and Activity or Faults Within the Cascadia Back-Arc Region of Central Oregon," and Olivier Vanderhaeghe, University of Minnesota, for "The Role of Partial Melting During Late-Orogenic Collapse: The Shuswap Metamorphic Core Complex, British Columbia, Canada." ■

SECTION RESEARCH GRANTS

North-Central Section

The North-Central Section awards grants for undergraduate research projects to students who attend a college or university within the North-Central Section geographic area. Research proposals are submitted and evaluated competitively. Recipients for 1996 are Katherine Cooper, Miami University; Brian Marlow, University of Toledo; Jeffrey W. Menken, Illinois State University; Tara L. Schrader, Indiana University/Purdue University; Karen Viskupic, Washington University; Sarah R. Vlachos, Iowa State University; and Michele H. Zimmer, University of Akron.

South-Central Section

The South-Central Section awarded grants to seven undergraduate students who attend colleges or universities within the South-Central Section geographic area as follows: Ryan Foster, Baylor University; J. Matthew Herrin, University of Oklahoma; Steven J. Kivett, University of Houston; Aaron John Kullman, University of Texas, San Antonio; Lisa Rottinghause, Baylor University; Demetra Salisbury, University of Arkansas; and Pendleton Wickersham, Rice University. The names of the recipients of the annual research grants awarded to qualified graduate students within the section will be announced later this year.

Southeastern Section

GSA's Southeastern Section awarded research grants to nine graduate students this year: Michael Bizimis and Zi-qiang Chen, Florida State University; Steven Jusczuk and Peter Nester, University of Tennessee, Knoxville; David C. King and Bryant Ramirez, University of Kentucky, Lexington; Anthony M. Rizzuti, University of South Carolina, Columbia; Steve Taylor, West Virginia University; and Berry H. Tew, Jr., University of Alabama, Tuscaloosa.

Northeastern Section

The Northeastern Section awarded grants to five undergraduate students. The 1996 recipients are Mary Jo Alfano, Hartwick College; Andrew C. Flint, Colby College; Richard M. Hodgson, Rutgers University, Newark; Jennifer McCord-Thompson, Kean College of New Jersey; and Brian R. Roosa, SUNY, Oneonta.

The Cordilleran and Rocky Mountain Sections do not currently offer student research grants.

October *BULLETIN* and *GEOLOGY* Contents

The Geological Society of America
BULLETIN
Volume 108, Number 10, October 1996

CONTENTS

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GEOLOGY
VOLUME 24
NO. 10
P. 865–960
OCTOBER 1996

Forum

Only new or changed information is being published in *GSA Today*. A complete listing can be found in the **Calendar** section on the Internet: **http://www.geosociety.org.**

1997 Penrose Conferences

April

April 24–30, **Paleocene-Eocene Boundary Events in Time and Space,** Albuquerque, New Mexico. Information: Spencer Lucas, New Mexico Museum of Natural History, 1801 Mountain Road NW, Albuquerque, NM 87104, (505) 841-2873, fax 505-841-2866, E-mail: lucas@darwin.nmmnh-abq.mus.nm.us.

September

September 10–15, **Faults and Subsurface Fluid Flow: Fundamentals and Applications to Hydrogeology and Petroleum Geology,** Albuquerque and Taos, New Mexico. Information: William C. Haneberg, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology, 2808 Central Ave., SE, Albuquerque, NM 87106, (505) 262-2774, fax 505-255-5253, E-mail: haneberg@mailhost.nmt.edu. For more information, see http://www.nmt.edu/~haneberg/Fluids.html.

September 23–28, **Tectonics of Continental Interiors,** Cedar City, Utah. Information: Michael Hamburger, Department of Geological Sciences, Indiana University, Bloomington, IN 47405, (812) 855-2934, fax 812-855-7899, E-mail: hamburg@ucs.indiana.edu.

1996 Meetings

November

November 20–22, **2nd Annual Strategic Environmental Research and Development Program (SERDP) Symposium,** Tysons Corner, Virginia. Information: SERDP Support Office, Labat-Anderson Inc., 8000 Westpark Dr., Ste. 400, McLean, VA 22102.

December

December 5–7, **Earth System Symposium,** North York, Ontario, Canada. Information: Vic Tyrer, Programs Branch, Ontario Science Centre, 770 Don Mills Rd., North York, Ontario M3C 1T3, Canada, (416) 696-3255, fax 416-696-3197, E-mail: vtyrer@osc.on.ca.

1997 Meetings

April

April 18–20, **National Fossil Exposition XIX,** Macomb, Illinois. Information: Karl Stuekerjergen, 1503 265th Ave., West Point, IA 52656, (319) 837-6690.

July

July 7–10, **3rd International Airborne Remote Sensing Conference and Exhibition,** Copenhagen, Denmark. Information: Robert Rogers, ERIM Conferences, Box 134001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234, fax 313-994-5123, E-mail: raeder@erim.org, WWW: http://www.erim.org/CONF/.

GSA MEETINGS

1997 ANNUAL MEETING

Salt Lake City, Utah
October 20–23
Salt Palace Convention Center
Little America Hotel

General Chair: ***M. Lee Allison,*** *Utah Geological Survey*
Technical Program Chairs: ***John Bartley, Erich Petersen,*** *University of Utah*
Field Trip Chairs: ***Bart Kowallis,*** *Brigham Young University*
Paul Link, *Idaho State University*

CALL FOR

1997 CONTINUING EDUCATION COURSE PROPOSALS

Proposals Due by December 1

The GSA Committee on Continuing Education invites those interested in proposing a GSA-sponsored or cosponsored course or workshop to contact GSA headquarters for proposal guidelines. Continuing Education courses may be conducted in conjunction with all GSA annual or section meetings. We are particularly interested in receiving proposals for the 1997 Salt Lake City Annual Meeting or the 1998 Toronto Annual Meeting.

Proposals must be received by December 1, 1996. Selection of courses for 1997 will be made by February 1, 1997. For those planning ahead, we will also consider courses for 1998 at that time.

For proposal guidelines or information, contact: Edna Collis, Continuing Education Coordinator, GSA headquarters, 800-472-1988, ext. 134, E-mail: ecollis@geosociety.org

FUTURE ANNUAL MEETINGS

1998 — Toronto, Ontario . . . . . October 26–29
1999 — Denver, Colorado . . . . . October 25–28
2000 — Reno, Nevada . . . . . November 13–16
2001 — Boston, Massachusetts . . . . . November 5–8
2002 — Denver, Colorado . . . . . October 28–31

1997 SECTION MEETINGS

NORTHEASTERN SECTION, March 17–19, Sheraton Valley Forge Hotel, King of Prussia, Pennsylvania. Submit completed abstracts to: Allan M. Thompson, Department of Geology, University of Delaware, Newark, DE 19716-2541, (302) 831-2585, thompson@bach.udel.edu. *Abstract Deadline: November 12, 1996.*

SOUTH-CENTRAL and ROCKY MOUNTAIN SECTIONS, March 20–21, University of Texas, El Paso, Texas. Submit completed abstracts to: Elizabeth Y. Anthony, Department of Geological Sciences, University of Texas, El Paso, TX 79968-0555, (915) 747-5483, anthony@geo.utep.edu. *Abstract Deadline: November 25, 1996.*

SOUTHEASTERN SECTION, March 27–28, Auburn University, Auburn, Alabama. Submit completed abstracts to: Charles E. Savrda, Department of Geology, Auburn University, Auburn, AL 36849-5305, (334) 844-4887, savrdce@mail.auburn.edu. *Abstract Deadline: December 2, 1996.*

NORTH-CENTRAL SECTION, May 1–2, The Concourse Hotel, Madison, Wisconsin. Submit completed abstracts to: Bruce Brown, Wisconsin Geological & Natural History Survey, 3817 Mineral Point Rd., Madison, WI 53705, (608) 263-3201, babrown1@facstaff.wisc.edu. *Abstract Deadline: January 9, 1997.*

CORDILLERAN SECTION, May 21–23, Kona Surf Resort and Convention Center, Kailua-Kona, Hawaii. Submit completed abstracts to: Fred MacKenzie, Department of Oceanography, University of Hawaii–SOEST, 1000 Pope Road, Honolulu, HI 96822, (808) 956-6344, fredm@soest.hawaii.edu. *Abstract Deadline: January 24, 1997.*

FOR INFORMATION ON ANY GSA MEETING CALL THE GSA MEETINGS DEPARTMENT
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Positions Open

UTAH GEOLOGICAL SURVEY

The UGS currently has vacancies for: 1) a geologist with experience in GIS and computer applications, 2) a project geologist with experience in coal geology and 3) a half-time geologic mapper. For detailed information, applicants are encouraged to visit the UGS home page at http://utst-dpwww.state.ut.us/~ugs/.

The state of Utah's Department of Human Resource Management (DHRM) has implemented an automated recruitment and selection system called Utah Skill Match. Resumes are scanned into a database and then matched against all available job openings within state government for a one-year period. Resumes must be submitted to DHRM to be considered for employment at the UGS. Instructions for submitting resumes are available on the UGS home page.

Future positions with the UGS are planned to be listed on our home page.

The state of Utah is an equal opportunity employer.

PETROLEUM RESEARCH POSITION
THE UNIVERSITY OF ALABAMA

The Department of Geology at the University of Alabama invites applications for a 1 year petroleum research position to begin December 1, 1996. The successful candidate must have an M.S. degree (Ph.D. preferred) in geology or allied field and 5–10 years experience in petroleum geology and computer application to solving geologic problems. Experience with geographic information systems and standard geological software is expected. Duties will include providing technical and computer assistance to oil and gas producers and assisting with the characterization of petroleum reservoirs and fields.

Applicants should send a resume, university transcript (unofficial) and names, addresses, and phone numbers of three references, to Chair, Search Committee, Department of Geology, University of Alabama, Box 870338, Tuscaloosa, Alabama 35487-0338. Review of applications began September 1, 1996, but applications will be accepted until the position is filled.

The University of Alabama is an equal opportunity, affirmative action employer which encourages applications from underrepresented groups.

SEARCH REOPENED
TENURE-TRACK POSITION IN
STABLE ISOTOPE GEOCHEMISTRY
UNIVERSITY OF NEW MEXICO

The Department of Earth and Planetary Sciences, University of New Mexico, is seeking a stable isotope geochemist for a tenure-track faculty position beginning in August, 1997. We anticipate hiring at the Assistant Professor level. Minimum qualifications include a Ph.D. at the time of appointment, a strong publication record, demonstrated potential for developing and maintaining active research and teaching (undergraduate and graduate) programs, and substantial experience in the operation of a stable isotope laboratory, such that the successful candidate shows promise of being able to effectively supervise, support, and enhance the operation of a departmental facility. The Department has a Nuclide isotope ratio mass spectrometer used for D/H measurements, and a Finnigan MAT Delta E isotope ratio mass spectrometer employed for carbon and oxygen isotope ratio determinations and associated extraction lines. A Secondary Ion Mass Spectrometer (SIMS) Laboratory also would be available for use by the successful candidate. Opportunities exist for collaboration with numerous departmental programs, related programs in other UNM departments, and programs at nearby Los Alamos and Sandia National Laboratories. The Department of Earth and Planetary Sciences has 19 full-time faculty and numerous technical support staff.

Applicants should submit a resume and the names, addresses, and phone numbers of four reference contacts, all transcripts, copies of publications, and a statement of research and teaching experience and interests to: Dr. Cornelis ("Kase") Klein, Geochemistry Search Chair, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131. To ensure full consideration, applications and all supplemental materials must be received by December 10, 1996. The University of New Mexico is an equal opportunity/affirmative action employer.

TENURE-TRACK POSITION
SCRIPPS INSTITUTION OF OCEANOGRAPHY

Applications are invited for a faculty position at the Assistant or Associate level in the broad area of marine sedimentology/stratigraphy/paleoceanography. The specific area of research is open but fields such as high-resolution paleoclimatology, carbonate and phosphate sedimentation, Mesozoic and Cenozoic ocean history, and Quaternary ocean dynamics would best complement existing research strengths. We intend to fill this position at the Assistant level (tenure-track), but will consider appointment at a higher level in exceptional circumstances; exact rank and salary will be commensurate with qualifications and experience in accordance with the University of California academic policy and pay scales. Applicants must show evidence of excellence and independence in research as demonstrated by their publication record and letters of reference and will be expected to maintain a strong extramurally-funded research program. The position will involve teaching and research supervision at the graduate level, and the appointee will be expected to play a role in the undergraduate Earth Sciences degree program. Applicants must hold a doctoral degree at the time of appointment. Applications should include a detailed resume with a description of research interests and teaching plans, a publication list, and the names and addresses of at least three referees. Send applications by November 15, 1996 to Chair, Sedimentology Search, SIO Graduate Department, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0208. UCSD is an Equal Opportunity/Affirmative Action Employer.

MINERALOGIST / PETROLOGIST

The Department of Geology at Bowling Green State University announces a tenure-track position at the Assistant Professor level. Fields of expertise and research interests should include mineralogy and/or petrology; a component of field-based research is highly desirable. The successful candidate will teach undergraduate mineralogy and/or petrology and other undergraduate and graduate courses in geology, participate in our summer field course in the western US, maintain an active research program, and supervise masters' level graduate students. A Ph.D. is required.

Facilities include: Microscopy laboratory (transmitted, reflecting, cathodoluminescence, and fluid inclusion microscopes); Mineral kinetics laboratory (cold-seal hydrothermal vessels and one atmosphere furnaces); Geochemistry laboratory (XRD; XRF; SEM; AAS); Sample preparation facilities; Field vehicles; Remote sensing laboratory; GIS Laboratory; Unix Workstations; ARC/INFO, ERMapper, AVS; and Geophysical facilities (magnetometer, gravity meter, shallow seismic, resistivity, GPS).

To assure full consideration, applications including a complete resume, statements of teaching and research interests, three original letters of recommendation, and transcript showing highest degree should be sent by November 15 to: Chair, Search Committee, Department of Geology, Bowling Green State University, Bowling Green, OH 43403. Bowling Green is an AA/EOC employer. Applications from underrepresented/protected groups are urged to apply.

PROFESSOR OF ISOTOPE GEOCHEMISTRY

We are seeking a creative scientist with an international reputation in the field of isotope geochemistry with particular experience in the application of radiogenic and noble gas isotopes in geochronology and as tracers in the crust and mantle. The new professor will be responsible for the development of mass-spectrometric and related analytical facilities, and coordinating research in the existing laboratory in isotope geochemistry/geology. Collaboration with other research units in the Departments of Earth Sciences and Environmental Sciences (e.g., geosphere-biosphere interactions) is expected.

The new professor should be a talented teacher. Teaching responsibilities will include basic and advanced courses in the above fields.

Applicants should submit a detailed résumé, publication list, statement of research interests and the names of three potential referees to the President of ETH Zürich, Prof. Dr. J. Nüesch, ETH Zentrum, CH-8092, Zürich, no later than November 30, 1996. In its effort to increase the number of women in top academic positions, the ETHZ specifically invites applications from female scientists.

GEOGRAPHIC INFORMATION SYSTEMS

The Department of Geoscience, University of Nevada, Las Vegas, seeks applicants for a tenure-track position in Geographic Information Systems (GIS) emphasizing geological applications.

The successful candidate will be expected to demonstrate excellence and enthusiasm in both research and teaching; establish a vigorous extramurally funded research program; supervise student research at the undergraduate and graduate levels; and develop and teach undergraduate and graduate-level courses in GIS with earth science applications as well as other geoscience courses.

Preference will be given to qualified applicants with demonstrated teaching abilities and research interests in fields such as geomorphology, remote sensing, surface hydrology, surficial processes, environmental earth science, soil dynamics, environmental geophysics, or neotectonics. Experience with both ARC/Info and PC-based GIS is desirable. Entry-level applicants will be given preference; in exceptional cases, other levels will be considered. Candidates must have a Ph.D. in geology, geography, or a related field at the time of hiring.

Evaluation of applications will begin October 10, 1996, with interviews beginning in November, 1996. Upon final review and approval by the Provost and pending budgetary approval, the successful candidate will start in August 1997.

Qualified applicants are encouraged to apply by sending a letter discussing your research interests and goals and the nature of the courses you have taught and/or would like to teach. Include a curriculum vitae; transcripts; and names, addresses, fax numbers, and e-mail addresses of four potential referees. Send all materials to Dr. Wanda J. Taylor, GIS Search Committee, Department of Geoscience; University of Nevada Las Vegas; Las Vegas, NV 89154-4010. UNLV is an Equal Opportunity/Affirmative Action Employer. People who are under-represented and who would add diversity are especially encouraged to apply.

UNIVERSITY OF NEVADA, LAS VEGAS
GEOSCIENCE EDUCATION
POST-DOCTORAL POSITION

We seek applicants for a post-doctoral position related to an interdisciplinary educational research project: "The Society Study of Geology." It is NSF funded potentially for three years. The Project for Multicultural and Interdisciplinary Studies and Education (PROMISE) includes the development and implementation of thematic modules and courses that incorporate the knowledge of natural and social sciences and feminist scholarship for use in high-school, undergraduate, and graduate science courses.

The successful candidate will be expected to demonstrate excellence and enthusiasm in both research and teaching; expertise in graphic software, World Wide Web, desktop publishing, and data-base management; willingness to participate in the development of learning modules and in various instructional components of the project; and

ability to work well with in-service and pre-service high-school teachers as well as other rmembers of the collaborative research-teaching group. Candidates must have a Ph.D. at the time of hiring. Preference will be given to highly qualified applicants with demonstrated teaching abilities, excellent backgrounds in earth and/or environmental scineces, knowledge of and interest in feminist approaches to interdisciplinary models of education and feminist critiques of science, and publication record in one or more of the above areas.

Evaluation of applications will begin in October 1996 with interviews beginning in November, 1996. We anticipate a start date of mid-January 1997. Initially, this will be an academic calendar appointment.

Qualified applicants are encouraged to apply by sending a letter discussing your interests and qualifications for this project. Include a curriculum vitae; transcripts; and names, addresses, fax numbers, and e-mail addresses of four potential referees. Send all materials to PROMISE Search Committee, Department of Geoscience; University of Nevada, Las Vegas; Las Vegas, NV 89154-4010. For further information contact Margaret (Peg) Rees, Department of Geoscience (702) 895-3890, rees@nevada.edu or Maralee Mayberry, Department of Sociology (702) 895-0237, mayberry@nevada, edu. People who would add diversity to our faculty and are underrepresented in the academy are especially encouraged to apply. UNLV is an Equal Opportunity/Affirmative Action Employer.

PRESCOTT COLLEGE

Prescott College, a private, liberal arts college, with a strong environmental mission, seeks candidates for three positions in Earth Sciences (emphasizing field geology, hydrology and soils, weather and climate, or other physical sciences), Environmental Policy and management (integrating natural sciences and social factors), and Environmental Education (with a solid foundation in Environmental Studies). Send letter of application, separate statement of educational philosophy, vitae, unofficial college transcripts, and names of three references who may be contacted by telephone to Ms. Kathy Coombs, assistant to the Dean of the Resident Degree Program, Prescott College, 220 Grove Avenue, Prescott, Arizona 86301. Applications must be postmarked by November 15, 1996.

IOWA STATE UNIVERSITY
GEOMORPHOLOGY/GEOPHYSICS

The Department of Geological and Atmospheric Sciences, Iowa State University, invites applications for a tenure-track position at the level of assistant-professor beginning in mid-August 1997. The position will be filled pending budgetary approval. The successful candidate will be expected to integrate their courses and research with the department's existing and emerging programs in hydrogeology and environmental science. Applicants must hold a Ph.D. in the geosciences; an emphasis on geomorphoogy or environmental geophysics is preferred. The successful candidate will be expected to conduct an active research program, supervise graduate students, attract external funding, and to develop and teach courses at the undergraduate and graduate level in his or her respective field. Applicants with a working knowledge of Geographic Information Systems and who can demonstrate their interest and ability in interdisciplinary teaching and research will be favored.

Applicants should send a letter of application, curriculum vitae, transcripts, statement of teaching and research interests, and the names, addresses, e-mail addresses and phone and fax numbers of at least three references to the address listed below by December 31, 1996. Carl F. Vondra, Iowa State University, Department of Geological and Atmospheric Sciences, 253 Science I, Ames, IA 50011-3212

Iowa State University is an Equal Opportunity/Affirmative Action Employer and encourages applications from women, minorities and other protected groups.

DEPARTMENT OF GEOLOGY
UNIVERSITY OF ILLINOIS AT URBANA–CHAMPAIGN
ASSISTANT PROFESSOR OF SEDIMENTARY GEOLOGY (TENURE-TRACK)

The Department of Geology at the University of Illinois invites applications for a full-time (9-month academic year) tenure-track faculty position in sedimentary geology. We are seeking an outstanding scientist and enthusiastic teacher for an appointment at the rank of assistant professor that will begin in August 1997. A Ph.D. is required; salary is negotiable. The successful candidate will establish an innovative, externally funded research program, preferably relating to tectonics and/or global change, and will pursue excellence in teaching and student-research supervision in all aspects of our educational program.

The University of Illinois at Urbana–Champaign is a major research university with 37,000 students in residence. Currently, the Department of Geology has 14 full-time faculty (see our homepage at http://www.geology.uiuc.edu/) and offers M.S. and Ph.D. degrees in geology and geophysics. Opportunities exist for collaboration with current staff in structural geology, hydrogeology, geochemistry, geophysics, clay mineralogy, and paleontology, both at the department and at the Illinois State Geological Survey.

To apply, please send a curriculum vita, a list of publications, a brief letter describing research and teaching interests and plans, and the names of three references to: Dr. Stephen Marshak, Search Committee Chair, Department of Geology, University of Illinois, 1301 W. Green St., Urbana, IL 61801. In order to ensure full consideration, applications must be received by December 10, 1996. For further information, contact Dr. Marshak by E-mail at smarshak@uiuc.edu, by telephone at 217-333-7705, or by Fax at 217-244-4996. The University of Illinois is an Equal Opportunity/Affirmative Action employer.

Services & Supplies

LEATHER FIELD CASES. Free brochure, SHERER CUSTOM SADDLES, INC., P.O. Box 385, Dept. GN, Franktown, CO 80116.

Opportunities for Students

Ph.D. Student Position Available. Applications are welcome for a Ph.D student position (start in late 1996) with the group for Mineral Resources and Processes of the Earth's Interior at the Swiss Federal Institute of Technology, Zürich, Switzerland. The successful applicant will be engaged in research on the chemical thermodynamics of hydrothermal fluids responsible for the formation of mineral resources in the Earth's crust. The main objective of this Ph.D. project is generation of quantitative data and models for describing two-phase (vapour + saline liquid) fluids as a basis for understanding the role of fluid phase separation in selective mobilisation and deposition of ore metals.

Research will focus on the calculation of thermodynamic properties of solute species in vapour, building on semiempirical ion hydration/association models and regression of published experimental data, together with equations of state to predict thermodynamic properties of aqueous species and electrolytes in liquid-like solvents up to very high salt-to-water ratios. Collaboration is anticipated with other Ph.D. students in the group working on hydrothermal ore deposits of magmatic origin in Switzerland, Australia, and Argentina to assess thermodynamic stability of Au, Cu, and Sn complexes in NaCl-dominated brines and coexisting vapour at high temperatures and pressures, and with experimental geochemists in the group of Prof. Terry Seward. These calculations will be combined with analytical data from synthetic and natural fluid inclusions to model metal partitioning in two-phase fluid systems, based on our new Laser Ablation ICPMS system.

A background in Earth Sciences is favourable but not essential for the project, and we particularly encourage chemists, chemical engineers, and (geo)physicists with an interest in aqueous geochemistry to contact Dr. Vitalii A. Pokrovskii or Prof. Christoph A. Heinrich at the Institute für Isotopengeologie und Mineralische Rohstoffe, ETH Zentrum, Zürich, CH-8092, Switzerland, fax +41 1 6321179, E-mail pokrovskii@erdw.ethz.ch.

The Swiss Federal Institute of Technology is an equal opportunity employer.

JOI/USSAC Ocean Drilling Fellowships. JOI/U.S. Science Advisory Committee is seeking doctoral candidates of unusual promise and ability who are enrolled at U.S. institutions to conduct research compatible with that of the Ocean Drilling Program. Both one-year and two-year fellowships are available. The award is $20,000 per year to be used for stipend, tuition, benefits, research costs and incidental travel, if any. Applicants are encouraged to propose innovative and imaginative projects. Research may be directed toward the objectives of a specific leg or to broader themes.

Proposals and applications for "shorebased research" should be submitted to the JOI office for the following deadlines: 11/15/96 and 4/15/97. Shorebased research may be based on any DSDP or ODP leg. The next "shipboard research" deadline is 4/15/97 and is for proposals based on future ODP Legs 176 to 181.

For more information and to receive an application contact: JOI/USSAC Ocean Drilling Fellowship Program, Joint Oceanographic Institutions, Inc., 1755 Massachusetts Ave., NW, Suite 800, Washington, DC 20036-2102 (Andrea Johnson; Tel: 202-232-3900, ext. 213; Internet: ajohnson@brook.edu).

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(Required by 39 U.S.C. 3685)

GSA Today (Publication No. 1052-5173) is published monthly by The Geological Society of America, Inc. (GSA), with headquarters and offices at 3300 Penrose Place, Boulder, Colorado 80301 U.S.A.; and mailing address of Post Office Box 9140, Boulder, Colorado 80301-9140 U.S.A. The Publisher is Donald M. Davidson, Jr.; the Editor is Faith E. Rogers; their office and mailing addresses are the same as above. The annual subscription prices are: for Members and Associate-Student Members of GSA, $7; for non-members $45. The publication is wholly owned by The Geological Society of America, Inc., a not-for-profit, charitable corporation. No known stockholder holds 1 percent or more of the total stock. CEDE & Company, 55 Water Street, New York, NY 10041, holds all outstanding bonds; there are no known mortgagees or holders of other securities. The purpose, function, and nonprofit status of The Geological Society of America, Inc. have not changed during the preceding twelve months. The average number of copies of each issue during the preceding twelve months and the actual number of copies published nearest to the filing date (September 1996 issue) were:

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ANNUAL MEETING AND EXPOSITION

DENVER, COLORADO • OCTOBER 28–31, 1996

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PALEOZOIC

VIEWS FROM THE

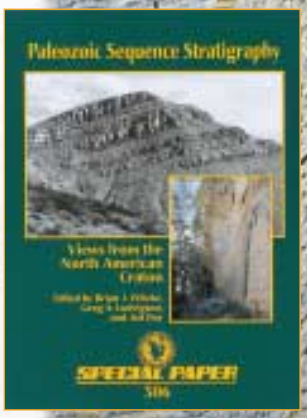
SEQUENCE

NORTH AMERICAN CRATON

STRATIGRAPHY

edited by Brian J. Witzke, Greg A. Ludvigson, Jed E. Day, 1996

Modern sequence stratigraphic ideas evolved in the petroleum industry during the 1970s and 1980s primarily from seismic investigations of Mesozoic-Cenozoic strata in basinal and continental margin settings. This volume refocuses on the Paleozoic cratonic heritage of sequence stratigraphy, with the additional perspectives from adjoining continental margins and foreland basins. Individual contributions evaluate a variety of stratigraphic, sedimentologic, diagenetic, geochemical, and paleontological problems within the common theme of sequence stratigraphy and depositional cycles. The authors adopt or adapt modern sequence stratigraphic concepts to varying degrees, and some examine the applicability of standard sequence stratigraphic terminology and paradigms to their Paleozoic examples. This volume covers topics spanning the Cambrian through the Permian, and provides a diversity of views focused within the North American craton.



SPE306, 452 p., indexed, ISBN 0-8137-2306-X, $115.00, Member price $92.00

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